Productivity and Labour Costs in the Ontario Metal Mining Industry

1975 to 1985: An Update

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THE AUTHORS

ALAN G. GREEN, Ph.D.
Professor, Department of Economics
Queen's University

M. ANN GREEN
Research Associate, Department of Economics
Queen's University

NOTE:

This background paper does not represent official policy and the views expressed herein are not necessarily the viewpoint of the Government of Ontario.

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By

Alan G. Green

M. Ann Green

September, 1987

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Executive Summary

Our investigation of the industry over the last decade suggests the following:

(i) Productivity growth in the Ontario metal mining industry continues to be slower than for the economy as a whole.

(ii) This slower growth in efficiency is not due to under-investment. In fact the annual growth of capital stock in the Ontario metal mining since 1980 is about equal to that in the country as a whole. Thus the industry is absorbing, through this investment, the latest technology.

(iii) The principal reason for the slower growth in multifactor productivity is the slow growth in markets for the industry's products. A combination of declining real output and expanding capital stock has forced down the growth in total factor productivity.

(iv) The growth of white collar workers was reversed in the eighties. This is an important finding since it calls into question the assumed complementarity between growth in fixed capital (machines and buildings) and quasi-fixed capital (non-production workers).

(v) The industry continued to down size its blue collar work force. This adjustment to new production levels has been accomplished, as one might expect, with a lag.

(vi) During the eighties the capital labour ratio increased sharply, i.e., capital was substituted for labour in the production process.

(vii) Capital costs have apparently escalated during the eighties. This is the joint result of higher interest charges, and steeply rising prices for capital goods. These added costs have not deterred producers, as the industry is currently undergoing an investment boom. One suspects, but cannot prove, that this investment boom is in anticipation of the resource boom expected in the nineties.

(viii) The relative rise in indirect labour costs to direct wages has been halted.

(ix) The cost of indirect payments per employee, however, has continued to rise. Thus one must conclude that the main factor forcing up total indirect labour costs is the growth in wages.
(x) A comparison of U.S. and Canadian direct and indirect labour costs reveals; (a) that in the early eighties Canadian average wages increased much faster than their American counterpart. However, in recent years the Canadian increase has been lower than that observed in the U.S.; and (b) that the share of indirect labour costs per dollar of gross payroll is slightly higher in Canada.

The overall conclusion is that the Ontario metal mining industry has made good progress towards adopting to new international competitive conditions. Current high levels of investment imply the absorption of new techniques. The "pay-off" in improved efficiency will probably have to await a return to stronger markets, and higher commodity prices.

Introduction

Dramatic changes have occurred in the metal mining sector over the last two and half decades. Some of these changes were reviewed in the Ministry study, "Productivity and Labour Costs in the Ontario Metal Mining Industry".[1] In particular this study investigated the impact of rising indirect labour costs and a shift towards white collar workers on the productivity performance of the metal mining industry during a period of sharply declining demand. This work covered the period from 1960 to 1977 -- the last date for which data were available. The study prepared here up-dates this earlier work covering the period between 1977 and the present.

During the period since the late 1970's, the industry has undergone a number of important adjustments. In particular it is now generally recognized that the downturn in demand that began in the seventies was not a short term event but one that would take some time to work itself back to more normal conditions. This study will review the performance of the sector during the last decade in light of these changing perspectives.

This work was commissioned by the Mineral Analysis and Statistics Section of the Ministry of Northern Development and Mines. We wish to thank the representatives of the Ministry for their assistance and support. Much of this report is based on information drawn from detailed surveys of mining labour costs. We are indebted to the various mining firms for providing this information. We wish to acknowledge the important contribution of Andrew Green. Andrew acted as a research assistant and was responsible for much of the computer

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1 Alan G. Green and M. Ann Green, Productivity and Labour Costs in the Ontario Metal Mining Industry, Mineral Policy Paper, Ontario Ministry of Natural Resources, 1985.

work. Finally we wish to thank Angela Street for her excellent typing of the manuscript. She showed great patience as the report went through its various drafts.

Chapter I

REVIEW

This chapter sets out the thrust of the original study[1] and reviews the main findings plus the recommendations for future research suggested by this earlier work.

Focus of Original Study

The central focus of the original study was on labour demand in the Ontario Metal Mining industry. Our main concern was with the relationship between labour productivity and labour rewards, i.e. the total labour costs incurred by the industry. The period covered was from 1961 to 1977.

The motivation for focussing on the behaviour of labour demand arose from the observation that the Ontario Metal Mining industry was faced with stiff external competition in world markets. With declining international base metal prices and new (highly subsidized) foreign supplies coming on stream, could the Ontario industry adjust to the new economic environment?

An important element in the total cost of production is labour. Thus two questions needed to be explored. First, what were the substitution possibilities between labour and other factor inputs, especially capital? Could producers actually adjust their production process in the short-run? Second, how much of the observed cost of labour was due to indirect labour

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1 Productivity and Labour Costs in the Ontario Metal Mining Industry, Mineral Policy Background Paper No. 19 (Toronto: September 1984). Hereafter "Productivity and Labour Costs".

costs, i.e., workmen's compensation, pension, holidays, etc., and how much to changes in direct labour wages, i.e., pre-tax take home pay?

The other set of questions dealt with the structure of the work force, i.e., blue vs. white collar workers. Our position in the first study was that white collar workers were, in the short-run, treated as quasi-fixed factors of production. Blue collar workers, on the other hand, were treated in the usual manner as variable factor inputs. Thus as demand fell producers could adjust the number of blue collar workers to lower levels of output.

The rationale for this differential treatment rests in human capital theory. Blue collar workers are seen, in the framework of this analysis, as having "general" human capital. This means simply that their skills are easily transferable between employers. The main implication for employers is that they can be laid-off without substantial cost since, should demand increase, replacement of the laid-off workers is easy and training is minimal.

White collar workers, on the other hand, are seen as holders of specific human capital. Their skills are specific to the industry. Hence if they are laid-off the employer, unable to rehire them later, must go to the expense of training new employees. Economic theory, therefore, suggests that over a short cycle employers are reluctant to lay-off workers with these specific skills.

In order to test these hypotheses in terms of developments in the Ontario Metal Mining industry we employed a simple Cobb-Douglas production function[2] to estimate partial and total factor productivity indices over the study period. Furthermore, we partitioned workers be-

2 The Cobb-Douglas production function is a simple relation between real output and the weighted sum of real inputs. Real inputs include capital, labour, materials and energy. The weights are the shares of factor cost in the total cost of production.

tween blue and white collar to see if indeed productivity differed between these two types of workers over time.

Finally, as mentioned above, we were concerned with the actual cost of labour to the industry. Published material at the level of detail we wanted was not available. To fill this gap we surveyed 15 Ontario Metal Mining companies accounting for over 75% of the sector's output to ascertain (a) the structure of labour costs between direct and indirect payments and (b) the changes in this distribution over time. This information on labour costs gave us, then, the other side of the picture to the relationship between the real outputs and real inputs as used in production theory.

Findings

As mentioned in the previous section the central purpose of the original work was to analyze, over time, the inter-relationship between wages, prices and productivity. Did, then, labour costs adjust to the new reality of lower product prices, i.e. did real wages rise or fall and how were these trends reflected in observed productivity changes?

The first step was to compare performance in the metal mining industry with other Canadian industries over the study period. This comparison revealed that the metal mining industry performed the poorest of any industry in Canada over the cycle of the 1970's vs. the 1960's.

Why should we observe this relatively poor result? Our study revealed the following possible causes.

1. The main conclusion was that over time the metal mining industry had become less flexible, i.e., it had lost some of its capacity to adjust to changing international markets.

2. One reason for this increased inflexibility revealed in our empirical work was the growing share of white collar workers. As explained above, their increased presence reduced the short-run flexibility of the industry.

3. The other major thrust was in the trend and structure of labour costs. We believed that some of these labour costs had been underestimated. An examination of our sample revealed:

   a. Indirect labour costs grew faster than direct labour costs. Indirect labour costs rose from 16% to 40% over the study period.

   b. This increase was largely concentrated in the early and mid-seventies.

   c. The increase in indirect labour costs was not uniform across all firms in the industry.

A simple overview of the metal mining industry over the sixties and early seventies suggested that the earlier decade was one of high capital investment. This factor added to efficiency and to the fixed costs of production. The seventies saw an almost complete reversal. Capital expansion virtually came to a halt. During the seventies the industry experienced a sharp rise in labour costs, especially indirect labour costs and a rapid growth in non-production (white-collar) workers. Apparently these added costs were paid for from profits and returns to land. The main problem came, then, when the anticipated revival in demand failed to materialize and prices continued to fall. The result was that with larger fixed obligations plus excess capacity, productivity fell sharply.

Recommendations

As this decade came to an end, the industry was having to cope simultaneously with several very difficult problems. First, falling metal prices and increased international competition were putting severe downward pressure on company profits. Second, the industry, with reduced output, had to adjust its input costs to these new market conditions. Thirdly, with slower growth and lower capital investment it faced the prospect of slower adaption of new technology and hence a potential further worsening of its competitive position on world markets.

Given these conditions we recommended that, when sufficient new evidence became available, an updated review be made of the way in which the industry coped with the new reality. This study presents such an update. Without pre-judging our detailed results our findings suggest that the industry has met the challenge and has begun a substantial restructuring of its production process.

Chapter II

THE ISSUES TO BE STUDIED

This chapter reviews the position of the metal mining industry within the context of current market conditions. It attempts to bring up-to-date the literature on the performance of this industry in the 1980's in order to place our new updated series in the appropriate context.

Competitive Position of the Industry

The Ontario metal mining industry, like that for Canada as a whole, is faced with strong competition in world markets. Changing metal needs resulting from the development of new materials and new production techniques have significantly changed the nature of the market. On the supply side new sources of supply have come on stream in recent years, much from third world countries. The combination, therefore, of slower growing demand and the outward shift in the supply curve has meant a stable or declining real price of metals, with the exception of gold.

Graph II-1, drawn from the recent (May, 1987) report, "The Mineral and Metal Policy of the Government of Canada",[1] shows clearly the impact of these events on Canada's relative share in Western World trade for selected metals. With the exception of coal, Canada's trade share is about the same for refined copper and slab zinc but down sharply for aluminum, iron ore and copper ore and concentrates. If we were to add gold, the picture for metals produced in Ontario, (except for iron ore) is one of relative stability over the last 20 years. This type of

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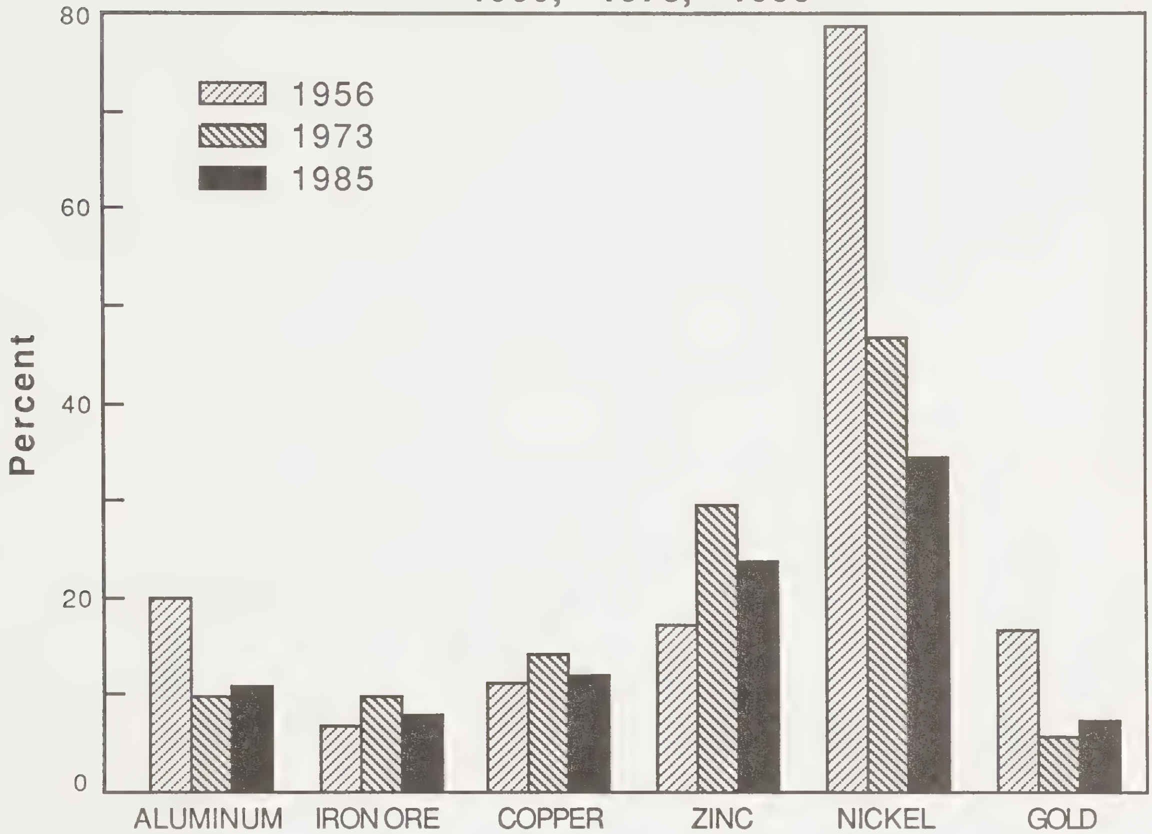
1 The Mineral and Metal Policy of the Government of Canada, (Energy Mines and Resources, Ottawa).

Graph II-1
Canadian share of Western World Production
of Selected Minerals and Metals
1956, 1973, 1985



NOTE: Smelter production for aluminum; mine production for remaining commodities.

Source: The Mineral and Metal Policy of the Government of Canada, Energy, Mines and Resources Canada, Appendix.

comparison, of course, does not reflect the devastating impact that lower world prices have exerted on the Ontario metal mining industry.

The trade share figures do suggest, however, that the relative competitive position of the industry, despite the negative effect of a relatively strong Canadian dollar vis a vis its main competitive countries, has remained firm. This attests to the ability of the industry to adjust its production methods and procedures to these changing world conditions. It is one of the jobs of this study to examine how this adjustment has been accomplished.

The Problem

In the conclusions to the original study it was suggested that the metal mining sector had not fully adjusted its production costs to the new reality of more competitive world markets. This was to be expected since it was impossible for producers to predict the future course of world mineral prices from their vantage point in the mid seventies.

As mentioned in the previous section the world market for minerals remained highly competitive into the 1980's. The question we face in this study, then, is "Did the Ontario Metal Mining industry adjust its cost position to meet the new competitive conditions for its products?"

We must look at the industry in the late eighties, even for the large production commodities like nickel and copper, as a price taker. In the past, given Canada's (and, within it, Ontario's) dominant world position much of the industry could be considered a price setter or at least a strong influence in the determination of world price levels for its output. Over the

last decade, then, the metal mining sector because of new sources of supply has shifted to a position where it must respond to world price changes rather than determining these prices.

As a price taker then, output, employment and wage levels must be adjusted to given market conditions. In essence this means that production decisions must adjust to what amounts to a perfectly elastic supply price of these minerals. Canadian and Ontario producers must, therefore, adjust their production decisions to maximize profits within this context. For example, changes in real wages should closely reflect productivity in the industry. If wages grow faster, then, the producer must either take lower returns or cut production (i.e., lay-off workers), since prices cannot be set independently of world levels.

Another way of saying this is that the industry must increase its efficiency to reflect this change in product wages, (nominal wages divided by commodity prices). If the latter are rising due to a fall in commodity prices then either productivity must increase, possibly through improved technology, industry restructuring or improved quality of labour, or nominal wages must decline. The latter is unlikely and hence the burden of adjustment must fall to some form of capital/labour substitution, as we suggested in the original study. This means new investment must be undertaken.

The goal here, then, is to see how the industry solved this problem of adjusting labour, and other input costs to stable or falling commodity prices. The central approach will, as in the original study be to use production theory[2] to sort out the causes of efficiency change in the industry between 1975 and 1985.

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2 For a definition of production theory see footnote #2, Chapter 1.

It is our intention to examine, in some detail, how producers reacted to this change in position, i.e., to examine how decisions are made in response to exogenous (given) market forces that affected the ability of Ontario metal producers to market their output.

Outline of Study

The basic focus of this study is to examine the response of the industry to this shift in position from being a price setting sector, at least for large producers, to being a price taker. Decisions had to be taken more in line with competitive firm behaviour where price equals marginal cost as opposed to an oligopolistic structure where price exceeds marginal cost at profit maximizing levels of output.

The shift to a position of price taker requires producers to adjust output levels more in line with the process that would be followed by competitive operators. The industry, however, was not free to simply make these adjustments unilaterally since it is bound by government regulations (i.e., pension payments, workmen's compensation, etc.) plus union contracts. We need to examine how the industry adapted its general output and efficiency in light of these constraints.

To accomplish this we propose to estimate partial and total factor productivity indices (Chapter IV), review capital and labour costs (Chapter V) and examine the relative shares of indirect labour costs (Chapter VI). Finally, we will compare U.S. and Ontario labour costs (Chapter VII).

Chapter III

THE DEMAND FOR METALS

This chapter will review the main trends in output for the Ontario Metal Mining industry over the period 1975 to 1985. This decade allows us to overlap the final years of the original study and bring the estimates as far forward as possible. The only reason for not coming up to 1987 is the unavailability of published data. We are interested also in the relationship between output and price. Accordingly the price elasticity of demand for gold, iron and "other" metals has been estimated.

Our ultimate goal is to examine efficiency change in this industry. The latter will be directly affected by two factors - the level of industry output at a point of time and the growth of industry output. The level of output influences the extent of capacity utilization. If the industry is operating below its optimum level then we would expect efficiency levels to be below their potential. We, unfortunately, do not have direct measures of capital utilization for this industry. However, it is possible to observe the status of the industry by comparing output levels over a period of time.

Efficiency is also affected by the growth of the industry. When the industry is expanding new capital is being installed. New capital brings with it the latest technology. Hence when we observe periods of high growth in capital formation there is the presumption of potentially large gains in efficiency, assuming, of course, that the new capital is not underutilized.

Change in output is therefore a key variable in any explanation of efficiency change. It is also important in understanding changing costs. For example, periods of rapid growth may

coincide with periods of relative input scarcity. This would serve to drive up the cost of these inputs, i.e., capital, labour, materials, etc. In Chapter V when we study cost trends, attention must be paid, then, to the basic state of demand for metals.

The chapter is organized as follows. In the first section we examine the trends in the growth of real output (ore hoisted) for Ontario metal mines. This measure is used, in Chapter IV, as part of the estimate of industry efficiency. In the second section price trends are reviewed. The price trends are then related, via simple economic equations, to real outputs in order to estimate demand functions for the three main groups - gold, iron ore and "other". In the final section a study is made of the value of production (Price times Quality) to see what structural changes have occurred in the sector over the last decade.

Growth of Real Output

Table III-1 sets out the annual compound rates of growth of ore hoisted for the period 1975-84 and for two sub-periods 1975-80 and 1980-84. In addition we have set out growth indices for gold, iron ore and "other". "Other" is taken as the residual production, i.e., the difference between total production (nominal or real) and the sum of gold and iron ore.

In 1961 the total number of tons of ore hoisted was 46.0 million short tons. By 1977 this had climbed to 59.9 million tons.[1] This was not a steady climb. Tons of ore hoisted declined to 39.0 million tons in 1963 and reached a peak of 67.0 million tons in 1970. The first point to make, then, is that we are dealing with a highly volatile industry in terms of market demand.

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1 See Ontario Metal Mining Statistics, op. cit., p. 59.

Table III-1

**Growth in Real Output (Ore Hoisted)
of Gold, Iron Ore, "Other" and Total Metals,
Ontario, Selected Periods 1975-1984.**

	1975-80 (1)	1980-84 (2)	1975-84 (3)
(1) TOTAL	-3.52	-0.80	-2.52
(2) GOLD	-2.20	9.42	3.22
(3) IRON ORE	-5.41	-6.18	-6.32
(4) "OTHER"	-2.33	0.76	-1.03

Sources: 1975-78: Ontario Metal Mining Statistics, Ministry of Natural Resources, Mineral Policy Background Paper No. 16.

1979-84: Metal Mines, Statistics Canada #26-223.

The volatility that was characteristic of the period before 1977 continued into the eighties. However, now it was around a downward trend. By 1985 total tons hoisted declined to 44.1 million tons. As Table III-1 shows this decline was not constant. The most rapid decline was in the late seventies, following the OPEC oil price adjustment. Production levels held relatively firm until 1977/78 and then plummeted. They fell only gradually between 1979 and 1984, although there was a sharp drop during the deep recession of 1982/83. We are studying an industry, then, which is experiencing a decrease in level of demand for its products.

The movements of the three metal groups shown in Table III-1 is different from the total, i.e., there are offsetting trends. Gold production moves at variance to the others. With higher gold prices, combined with new sources of supply (Hemlo) production levels rose after 1980. This is in sharp contrast to the "other" group (i.e., copper, silver, lead, etc.) which experienced declining real output growth at about 1.0% per year. Iron ore production was the most heavily hit of the three groups. This was due to the combined influence of a world wide decline in steel demanded and the advent of Brazilian output on the world market.

The divergence in industry real output trends implies potentially different productivity responses over our test period. In the case of gold mining we would expect, given the rapid growth in the industry, an increase in efficiency. This arises from the additions to capacity. New capital equipment embodies the latest techniques, and hence should enhance both labour and total factor productivity. The iron ore industry is the opposite. With steeply declining levels of real output (ore hoisted) the industry should be experiencing excess capacity and plant closures. The outcome is somewhat uncertain, although one presumes a downward trend in labour and total factor productivity. For "other" the outcome is uncertain since real output levels are fairly constant. Overall, then, we should not expect a great boost in efficiency due to demand related factors.

Price Trends

(i) Real Metals Price Index

Table III-2 and Graph III-1 set out the index of real metal prices for the period 1957 to 1986. Real metal prices are estimated by deflating nominal prices by the gross national product deflator. To provide some perspective on Canadian trends, indices for U.S. metal prices have also been included. The indices for both countries are partitioned between those including and those excluding the gold index. The latter followed a much different time path than did trends in other metal prices.

Our primary concern is with the movement of real metal prices over the last decade. During this period the Canadian index declined from 129.47 in 1975 to 100.00 in 1986, or a decline of 29 index points. If gold is excluded the index declines from 108.04 (clearly in the years immediately preceding 1975 gold prices rose relative to all metal prices) to 76.53 or a decline of 32 index points. This larger decline (in percentage point terms) is what we would expect given the poorer markets for metals other than gold.

The U.S. indices tracked very closely the Canadian real prices, although real prices fell further than in Canada. Between 1975 and 1986 the total index fell 47 index points and when gold is excluded the index fell 45 index points. The impact of rising gold prices played a smaller role in the U.S. index. This occurs since gold production as a percentage of total metal production is smaller in the U.S. than in Canada.

The main conclusion we can draw from this exercise is that metal prices moved up (or fell) less rapidly than did all prices in the economy. In other words the industry faced a relative

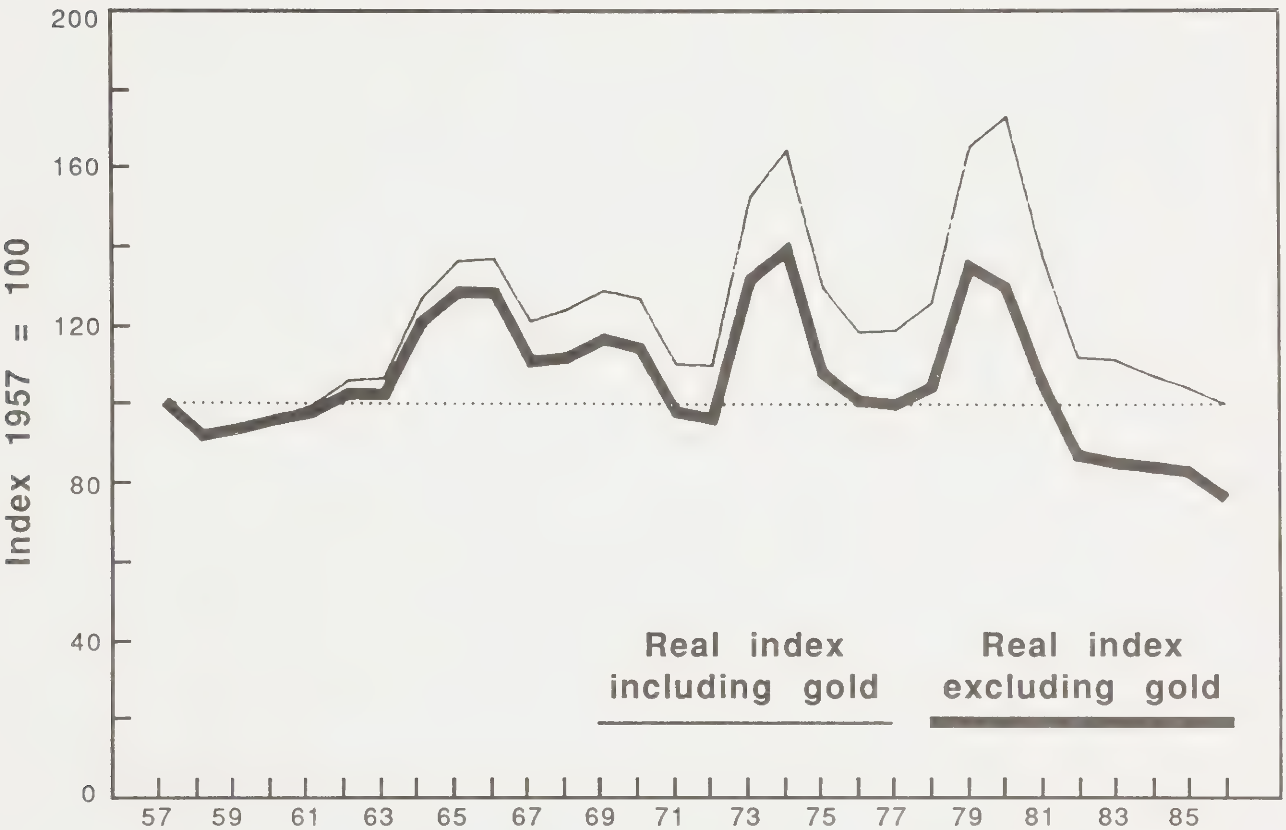
Table III-2

EFPAB Real Metals Price Index: Summary

	CDN $ INDEX 1957=100	CDN $ INDEX EX GOLD 1957=100	US $ INDEX 1957=100	US $ INDEX EX GOLD 1957=100
1957	100.00	100.00	100.00	100.00
1958	90.40	91.79	89.08	90.45
1959	94.17	93.56	93.54	92.94
1960	96.61	95.84	94.57	93.81
1961	99.26	97.71	92.57	91.12
1962	105.79	102.50	93.07	90.17
1963	106.50	102.46	93.19	89.65
1964	126.25	120.62	111.41	106.44
1965	136.07	128.26	121.40	114.43
1966	136.57	128.07	123.34	115.66
1967	120.83	110.81	110.05	100.92
1968	123.80	111.75	111.75	100.86
1969	128.48	116.43	115.14	104.34
1970	126.47	114.05	116.05	104.65
1971	110.10	97.94	102.74	91.39
1972	109.75	96.26	105.24	92.30
1973	152.09	131.47	149.02	128.81
1974	164.12	138.97	173.99	147.30
1975	129.47	108.04	133.90	111.72
1976	118.21	100.80	131.49	112.12
1977	118.56	99.87	124.04	104.47
1978	125.69	104.46	121.87	101.28
1979	165.05	134.92	158.13	129.25
1980	172.72	129.48	169.19	126.83
1981	137.78	106.15	133.06	102.51
1982	111.91	87.19	108.97	84.89
1983	111.33	85.30	110.11	84.36
1984	107.40	84.28	100.16	78.60
1985	104.18	83.04	92.08	73.39
1986	100.10	76.53	87.20	66.66

Source: The Mineral and Metal Policy of the Government of Canada, Energy, Mines and Resources Canada, Appendix, page 15.

Graph III-1
Canadian Real Metal Price Index
1975 - 1986



NOTE: Index adjusted using the GNE deflator. Index weighted by production including copper, iron ore, zinc, gold, nickel, silver, lead and molybdenum.

Source: See text.

price decline. We might expect, then, a decline in the growth of real output and a shift of factors of production to other sectors where relative rewards must have been rising.

(ii) Nominal Prices

Our main concern in estimating demand functions for the three metal groups is with nominal rather than real prices. Table III-3 shows nominal price trends for a number of metals, annually, from 1957 to 1986. These are the actual price levels - the ones that will be used to estimate price elasticities. We will examine the movement of each metal separately and show the results of our regression estimates of demand for gold, iron and "other".

Demand for Metals

To estimate the elasticity of demand for the three groups of metals we estimated the reduced form of the following set of equations:

$$Q_D = \alpha + \beta P \quad (1)$$

$$Q_S = \gamma + \gamma P + \theta r \quad (2)$$

$$Q_D = Q_S$$

The endogenous variables are Q and P and the estimating equation is as follows:

$$Q_D = \alpha + \beta P' + v$$

where

Table III-3

Metal Prices in Canadian Dollars

	COPPER	LEAD	ZINC	NICKEL	SILVER	GOLD	MOLY	IRON
	Cc/lb	Cc/lb	Cc/lb	Cc/lb	Cc/oz	Cc/oz	Cc/lb	Cc/LTU
1957	26.735	11.743	9.916	70.951	87.078	3355.8	133.273	26.25
1958	24.339	9.005	8.153	71.824	86.422	3397.1	135.884	25.98
1959	28.967	8.648	10.034	70.966	87.461	3356.5	140.973	25.03
1960	30.868	8.910	11.030	71.758	88.601	3394.0	142.546	23.29
1961	30.070	8.270	10.014	78.678	93.670	3546.2	157.046	24.79
1962	32.382	7.667	9.183	85.400	115.837	3741.2	171.024	26.59
1963	32.606	8.688	10.515	85.202	137.951	3774.8	172.560	25.99
1964	48.979	13.802	16.103	85.209	139.463	3775.1	184.441	25.97
1965	65.273	15.740	15.446	84.809	139.385	3773.0	188.650	25.96
1966	76.888	12.990	13.923	84.999	139.360	3770.6	188.528	25.65
1967	57.042	11.270	13.519	94.682	167.166	3775.5	196.323	24.50
1968	62.286	11.907	13.004	102.363	231.081	4316.5	196.105	23.89
1969	73.692	14.317	14.142	113.513	192.823	4469.8	203.515	23.23
1970	66.709	14.363	13.970	134.660	184.872	3801.2	200.448	25.54
1971	49.767	11.635	14.192	134.303	156.075	4165.4	193.882	24.32
1972	48.136	13.550	16.964	138.340	166.850	5788.9	190.176	23.45
1973	80.880	19.463	38.548	153.015	255.786	9759.3	192.019	27.19
1974	91.033	26.234	54.806	169.683	460.442	15610.3	219.072	31.09
1975	57.064	19.054	34.380	210.920	449.496	16395.3	278.740	40.45
1976	63.210	20.174	31.847	222.464	429.295	12320.2	321.469	41.64
1977	63.199	29.775	28.474	243.010	491.658	15737.4	427.527	46.88
1978	70.547	34.048	30.653	238.370	615.809	22055.6	1052.405	50.45
1979	105.309	63.870	39.465	319.798	1299.683	36037.1	2783.484	58.56
1980	116.173	48.178	40.309	345.790	2411.831	71602.3	1094.106	65.24
1981	95.352	39.922	46.679	324.809	1261.153	55107.7	767.370	71.54
1982	82.821	30.428	41.631	269.404	980.774	46403.4	506.012	75.98
1983	88.884	23.752	42.798	261.269	1410.023	52232.6	448.615	73.99
1984	80.919	26.047	52.386	280.195	1054.053	46650.0	460.690	76.76
1985	88.562	24.358	47.710	308.262	838.530	43317.7	443.280	80.54
1986	86.779	25.605	44.540	244.673	759.995	51111.4	398.897	81.30

Prices were converted into Canadian $ at the average annual exchange rate.

Copper: LME Cash Wirebar (1957-1980, LME High Grade Cathode Cash (1981-1986)
Lead: LME Cash
Zinc: LME Standard Grade Cash
Gold: Handy & Harman
Silver: Handy & Harman
Molybdenum: USBM Technical Molybdic-oxide Price (1957-1979, Metals Week Dealer Oxide (1980-1986)
Nickel: Metals Week US Dealer Cathode (1957-1979), LME Cash (1980-1986)

Source: Energy, Mines and Resources, Ottawa.

P = current nominal price of a metal.
P′ = the estimated price on shift factor as derived from equation (2) above.
r = real corporate bond yield.
V = error term.

The method used to estimate the demand curve for various metals can be illustrated in Chart III-1. Our basic assumption is that we are observing movements along the demand curve. This implies that factors such as technology in use, income growth and population change, the usual factors that account for a shift in the demand curve, are insignificant during our test period (1975-85). However, this is not the case for supply of metals. The assumption here is that supply has shifted outward over the last decade. This outward shift is accounted for by technological change and new discoveries where the cost of extraction is less than for current mining operations. We make no attempt to sort out which factor is more important.

However, even if we cannot sort out whether technological change or new supply is the most important explanatory variable, we need a proxy for a supply shift. We chose the corporate bond yields as the exogenous variable moving the supply curve outward. This choice is based on simple Fisherian theory. The latter hypothesizes that the interest rate is positively related to the rate of extraction. In other words as the real cost of capital rises the rate of extraction also rises since it pays the owner of the resource to monetize his resource and invest the proceeds. A lower real interest rate extends the time horizon and slows the rate of extraction.

Data

Before we talk about the regression results it might prove helpful to discuss the derivation and trends, where appropriate for the data used in the model. We have already discussed trends in ore hoisted so no further comment will be made on the dependent variable.

Nominal Metal Prices

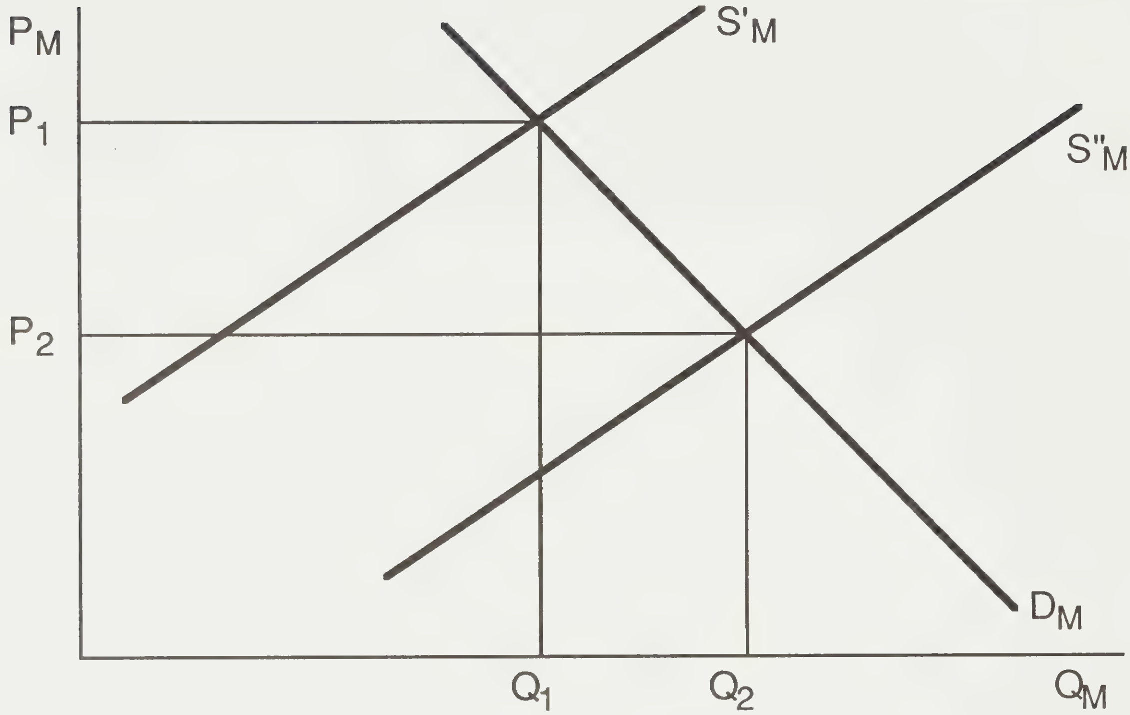
(i) Gold

Table III-3 shows the nominal value of an ounce of gold expressed in cents per Canadian dollar. Three points are worth noting. First, although it is before our test period, the price of gold shifts upward sharply between 1967 and 1968. This is the period when a two tiered market emerged - part free market and part price set on official monetary transactions. Before that all gold had to be purchased by the central bank at a fixed price. Canadian gold mines were somewhat protected before 1972 by the EGMAA which provided for sale to the Mint in Ottawa on a cost-plus basis. Second, the next major jump came in the late seventies and lasted until 1980. This was a period of unease in the expected prosperity of the major economies. People were buying gold out of a fear of run away inflation. Finally, following the great recession of 1982 the price of gold softened but it still remains high in terms of post-war history.

(ii) Iron Ore

The Great Lakes' price of iron ore followed an upward trend between 1975 and 1985, i.e., in 1975 it was selling for $40.45 a long ton. By 1988 this had increased to $81.30 a long ton. A caveat is necessary at this point. During the last decade the world price of a ton of iron ore

Chart III-1



Demand for Metals

has shifted from a Great Lakes price to a Brazilian price. This reflects the basic change in the source of supply, i.e., towards Brazil.

(iii) "Other" Metals

"Other" represents the residual components of metal mining, i.e., after gold and iron ore have been subtracted from total output. It, therefore, is a heterogeneous category. The main components included are nickel, copper, zinc, lead and silver. It is difficult, therefore, to draw as firm conclusions for this component as it was for gold and iron ore.

Given the heterogeneous nature of this group it might help if we relate the main trends in output to the prices of nickel, zinc and copper. First the prices of all four minerals rose sharply between 1975 and 1980, indeed 1980 was the high point for prices. Thereafter the trend was downward for all four, although there were differences in movements between them on an annual basis. (See Table III-3). Output trends moved quite differently. Between 1975 and 1979 the amount of ore hoisted declined from 30.7 million to 22.0 million tons. After 1977 the trend was mixed rising to 1981, then falling sharply in 1982 - a year when prices fell sharply and then rising again to 27.6 million tons in 1985 - a period when prices of copper and zinc rose but lead continued a downward trend.

The price index used to estimate the regression equation for "other" was derived by weighting the individual prices for nickel, copper and zinc by the volume of production of these three metals over our test period.

Interest Rates

The theoretically correct interest rate is the long-term bond rate. We chose the yield on long term corporate bonds since they, supposedly, had a higher risk component built into them than would be the case for long term federal bonds. The corporate yields were deflated by the GNP deflator.

Table III-4 sets out the regression results. The expectation is that the estimated coefficient on the P′ variable would be negative. This is the case for iron and "other" metals. Also in both of these cases the coefficient is statistically significant, although only weakly significant for "other". Since "other" is a composite (i.e., copper, lead, silver, zinc), we might expect a poorer fit. The results for gold are disappointing but not entirely unexpected. During the last period the price of gold rose sharply, and over fairly long periods. It is certainly not the case that price and quantity (of ore extracted) are inversely related.

Finally it appears that the price elasticity of demand for iron is greater than it is for the composite group "other". Thus a 10% drop in price will have a greater increase in the quantity demanded for iron than is the case for "other". We will need to do more work on estimating demand curves for these metals before a definitive statement on elasticity can be made. However it seems that the demand for labour in iron mining, i.e., a derived demand, is more sensitive to final price than is the case for the "other" group.

Table III-4

Regression Results for Demand
For Gold, Iron and "Other

	C (1)	P' (2)	$\bar{R}^2$ (3)	$D \bullet W$ (4)
(1) GOLD	14.99	0.0141	- 0.12	0.650
		(26.322)	(0.144)	
(2) IRON	22.65	-1.454	82.5	1.24
		(20.84)	(-5.467)	
(3) "OTHER"	19.88	-0.642	0.06	1.87
		(10.18)	(-1.44)	

Where: C = constant term
P^1 = estimated price
$\bar{R}^2$ = adjusted
$D \bullet W$ = Durban-Watson *Statistic*

Value and Structure of Production

Up to this point we have examined the movement of quantities and price, separately and in simple demand relationships (i.e., regressing quantity of ore hoisted on prices). It remains only to study the interaction of these two variables, i.e., price times quantity, on the sales value of output for the metal mining sector. These are shown in Table III-5 both in terms of annual rates of growth and as percentage of total output.

(i) Growth

The trends in value terms are different from those reported in Table III-1 for ore hoisted (real terms). For total metals the real trends showed negative rates of change over all periods. In dollar terms the results are mixed. Over the whole period the sales price (i.e., Price times Quantity) increased at 5.0% per year - less however than the rise in the GNP deflator. This was sufficient to offset the fall in quantities hoisted. In gold, as one might expect the growth in value was positive over all periods. "Other" which as we will see dominates total metals moved in parallel to the sector as a whole. It is certainly the case that metal mining has not moved, in value terms, with the rest of the economy. This we presume has had some effect on the industry's performance.

(ii) Shares

Panel B of Table III-5 and Graph III-2 set out the distribution of output for the three metal groupings. First the "other" category dominates this sector. Second "other's" share has remained virtually invariant over the study period. Third, during the decade 1975-85 gold and

Table III-5

Growth and Share Distribution
Of Gold, Iron, "Other" and Total Metals, In Terms
Of Current Dollar Value of Output
1975-1984

(A) Annual Rate of Growth

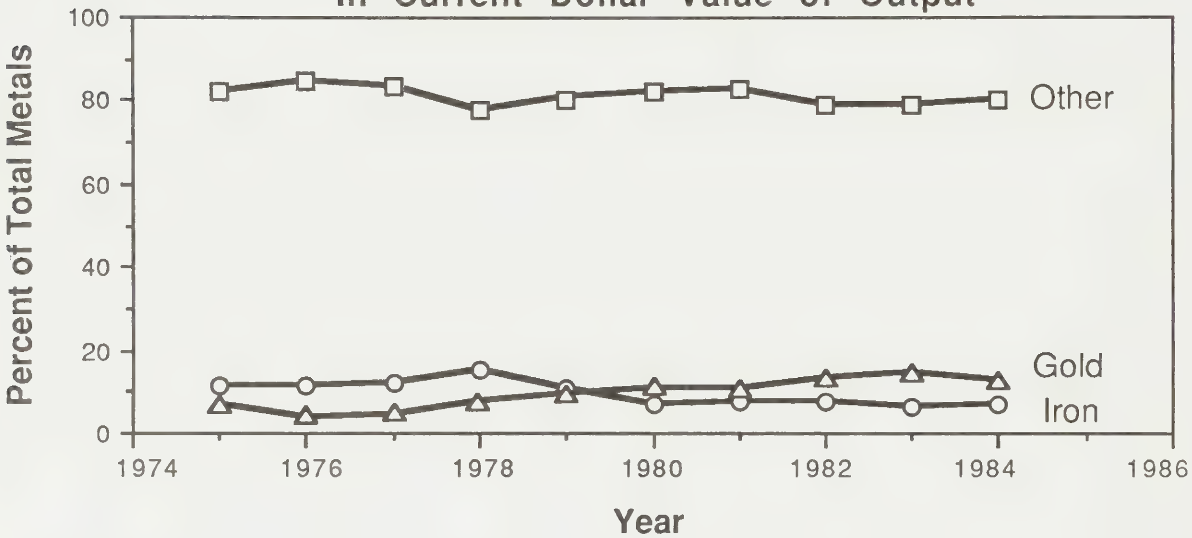
	1975-80 (1)	1980-84 (2)	1975-1984 (3)
TOTAL	12.01	-3.09	5.38
GOLD	22.76	0.06	13.13
IRON	2.94	-3.18	0.12
"OTHER"	11.97	-3.53	5.11

(B) Shares

TOTAL	100.0	100.0	100.0
GOLD	7.1	12.3	9.3
IRON	11.2	7.0	9.6
"OTHER"	81.7	80.7	81.1

Source: See Table III-1.

Graph III-2
Share Distribution of Gold, Iron & "Other" Metals
In Current Dollar Value of Output



iron changed places, with the former growing at about the same rate that value of production in the latter fell.

This chapter has given an overview of the changing pattern of the market for Ontario metal production since 1975. Chapter IV puts the inputs with these outputs, estimates and analyzes efficiency trends in the sector.

Chapter IV

PRODUCTIVITY CHANGE IN THE ONTARIO METAL MINING INDUSTRY: REVIEW AND UPDATE

In the original study estimates of partial and total factor productivity were made for the period 1961 to 1977. The principal findings were (1) that after substantial total factor productivity growth in the sixties, efficiency advance slowed sharply in the seventies, especially the late seventies; (2) total labour productivity growth was mixed, i.e., positive in the sixties and late seventies but negative between 1972 and 1975 and (3) productivity change in materials and energy was negative from 1961-75. However, the weight of energy in the estimate of total factor productivity was so small (less than 4% of total cost) that trends in overall efficiency were explained largely by changes in the relationship between output and labour input and the latter was influenced by the growth of white collar workers. How, then, has efficiency changed over the last decade? We answer this question using essentially the same methodology adapted in the original study.

Model

We will not review, in detail the theory of production since this was discussed extensively in Chapter 1 of the original study (see page 58-59 in particular). Briefly, production theory relates the growth of real output to the growth of real inputs where the latter are summed using the factor shares of the inputs as the weights. The basic production function is a constant returns Cobb-Douglas form, i.e., doubling inputs also doubles output. The elasticity of substitution among the factors is assumed to be one. The production equation takes the following form:

$$Y = A\left[f\left(K^{S_k}, L^{S_l}, M^{S_m}, E^{S_e}\right)\right] \quad (1)$$

where

Y = real output (tons of ore hoisted)
A = technological change (the efficiency measure)
K = real capital stock
L = man-years of labour
M = materials used
E = energy consumed

Expressed in ratio of growth terms this equation becomes

$$\frac{\hat{Y}}{Y} = S_k \frac{\hat{K}}{K} + S_l \frac{\hat{L}}{L} + S_e \frac{\hat{E}}{E} + S_m \frac{\hat{M}}{M} + \frac{\hat{A}}{A} \quad (2)$$

where $\hat{}$ = rate of change, e.g. $\frac{Y_t - Y_{t-1}}{Y_{t-1}}$

S_k, S_l, S_e and S_m = the factor shares of capital, labour, energy and materials respectively.

Total Factor Productivity is

$$\frac{\hat{A}}{A} = \frac{\hat{Y}}{Y} - \left(S_k \frac{\hat{K}}{K} + S_l \frac{\hat{L}}{L} + S_e \frac{\hat{E}}{E} + S_m \frac{\hat{M}}{M}\right) \quad (3)$$

(pp. 58-59, Original Study, revised)

Total factor productivity ($\hat{A}$) measures the growth in real output not accounted for by the growth in traditional factors of production, above i.e., capital (which includes land), labour, energy, and materials, etc. As such, total factor productivity measures technological change in the industry plus economies of scale and improvements in the quality of the labour force.

It is possible to partition the traditional inputs. For example equation (2) assumes that labour is homogenous, i.e., it does not allow for the effect of differences in skill, age, sex, etc. In the original study (pp. 64 ff) we divided labour into white collar and blue collar workers. Such a division produces the following production function.

$$Y = A\left[f\left(K^{S_k}, L_B^{S_b}, L_w^{S_w}, E^{S_e}, M^{S_m}\right)\right] \tag{4}$$

and total factor productivity becomes

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \left(S_k \frac{\dot{K}}{K} + S_b \frac{\dot{L}_B}{L_B} + S_w \frac{\dot{L}_w}{L_w} + S_e \frac{\dot{E}}{E} + S_m \frac{\dot{M}}{M}\right) \tag{5}$$

where

L_B = number of blue collar workers
L_w = number of white collar workers
S_b and S_w = factor shares of blue and white collar workers

Factor Shares

The distribution of factor shares is shown in Table IV-1. Recall that factor shares measure the marginal contribution of a given factor to a change in real output. They measure, then, the marginal productivities of the various factors. We have included the shares for white (non-production) and blue (production) workers in the list of inputs.

In the original study we looked carefully at the use of energy since its cost had risen steeply after 1974. The eighties saw a reversal in this upward trend with oil and gas prices falling. Under these conditions we would expect producers to increase their use of this factor.

Table IV-1

Mean Cost Shares of K, L, B, W, E and M Inputs in Ontario Metal Mining: 1961-1984

Year	S_K	S_L	S_W	S_B	S_M	S_E
1961-71	.4266	.2123	.0458	.1665	.3407	.0222
1972-74	.4643	.1873	.0585	.1288	.3237	.0247
1975-77	.3984	.2095	.0598	.1497	.3554	.0367
1978-81	.3203	.2334	.0721	.1605	.3902	.0403
1982-84	.4171	.2317	.0664	.1597	.3060	.0452

Notation: K = aggregate capital and return to land
L = aggregate labour
W = non-production workers
B = production workers
M = aggregate materials and supplies
E = aggregate energy.

Source: For years 1961-77: Ontario Metal Mining Statistics, op. cit.,
For years 1978-84: Metal Mines, Statistics Canada, Cat. #26-223.

Table IV-1 suggests this was the case since the share of energy costs rose from .0367 in 1975-77 to .0452 in 1982-84. Energy remains, however, a small component of total input costs.

The other factor which occupied our attention was the growth in the use of white collar workers. As Table IV-1 shows the cost share of this factor rose to a peak of 0.0721 in 1978-81 and subsequently declined. Since nominal wages for this group did not fall, its declining share suggests that the upward trend in the use of non-production workers has been reversed. On the other hand the share of blue collar workers, which had been falling, began to rise after 1975-77. Overall, though, perhaps because the mining industry is more technically sophisticated in the eighties than it was in the sixties, the share of white collar cost is much higher than in earlier periods.

Finally the share of capital service cost rose dramatically in the eighties compared to the seventies, i.e., by 1982-84 it was 0.4171 compared to 0.3984 in 1975-77. This rise reflects the sharp increase in investment in this industry during the eighties. The shares now are very close to their level in the sixties - the last period of substantial investment boom.

Output vs. Input Growth

Before we begin to analyze productivity trends, it might be useful to view the annual growth rates of real output and real inputs. Table IV-2 sets out these rates from 1961-72 to 1981-84. These are calculated as compound rates of growth. Graph IV-1 shows growth of output, capital and labour

As Col. (1) of Table IV-2 shows, real output growth has fallen sharply since 1972, i.e., at a rate of -5.82% between 1977-81 and -0.77 for 1981-84. We are studying efficiency change,

Table IV-2

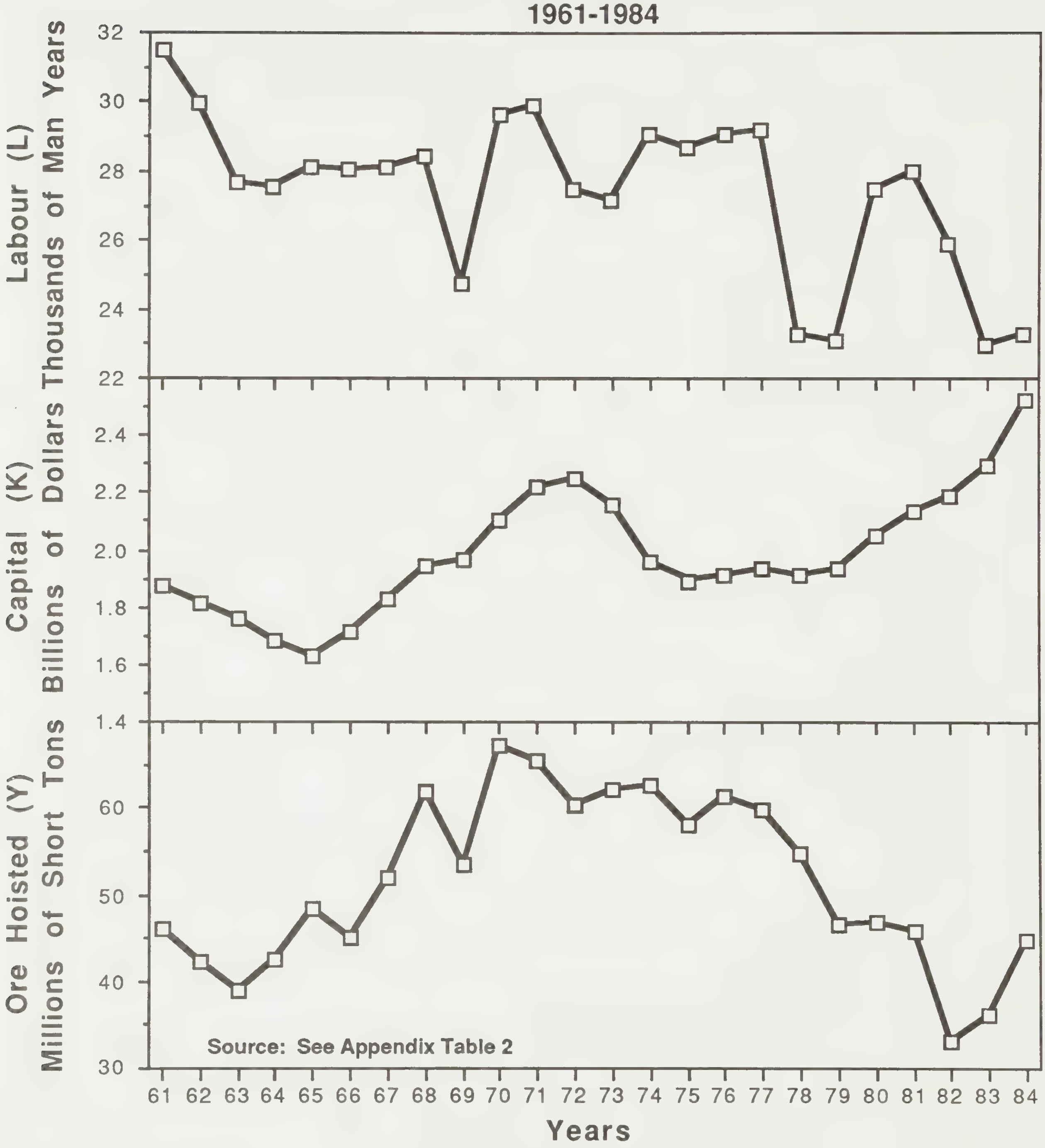
Average Annual Growth Rates of Quantitites of Output and Inputs, Ontario Metal Mining Sector, 1961-1984

	Y (1)	K (2)	L (3)	W (4)	B (5)	M (6)	E (7)
1961-72	2.50	1.63	-1.24	3.28	-2.14	4.73	9.03
1972-75	-1.39	-5.71	1.44	3.61	0.82	-1.32	2.60
1975-78	1.66	1.37	0.88	0.37	1.03	1.48	0.44
1977-81	-5.82	2.54	-1.04	3.36	-2.33	-1.17	-7.85
1981-84	-0.77	6.31	-5.56	-7.78	-4.74	-7.12	.64

Source: For years 1961-77: Ontario Metal Mining Statistics, op. cit.
For years 1978-84: Metal Mines, Statistics Canada, Cat. #26-223, by year.

Notation: Y = real output (ore hoisted)
K = capital stock (calculated using perpetual inventory method)
L = man-years of labour
W = man-years of non-production workers
B = man-years of production workers
M = materials and supplies
E = energy (B.T.U's)

Graph IV-1
Quantities of Output (Y) and Inputs (K,L)
Ontario Metal Mining Sector
1961-1984



therefore, in a declining industry - the decline being measured in real, not nominal, terms. Labour input also fell, declining very dramatically between 1981 and 1984. This sharp decline in the rate of growth of labour input was due to a fall in the employment of white and blue collar workers. In fact, for the first time since the early sixties the growth in white collar workers turned negative.

In the original study it was suggested that the slow response (downward) in the number of white collar workers relative to changing output levels may have been due to labour hoarding, i.e., a reluctance to release specific human capital skills. It meant, therefore, a relative growth in white vs. blue collar workers. In fact, this process was exacerbated in the late seventies as growth in white collar workers increased sharply while the number of blue collar workers continued to decline.

The important observation here, then, is that by 1981 firms were beginning to re-adjust their thinking on the number of white collar workers employed. For the first time in 20 years the rate of growth turned negative (i.e., -7.78% from 1981 to 1984).

Two interesting conclusions follow from this turn around in the growth in white collar workers. First, the continued decline in the size of the industry - a consequence of the large decline in real output, has meant a reassessment by managers as to the cost of this component of their labour force. The belief that the downturn may be of a longer duration than was originally thought may have had something to do with reducing the number of white collar workers. Second, the decline in the latter suggests that the concept of white collar workers as quasi-fixed factors of production needs to be correct. Although it may prove impossible to "lay-off" true fixed factors of production even in the medium term, it is not impossible to reduce quasi-fixed factors.

To examine how this reversal in growth in white collar workers affected different industries (gold, iron ore and "other") and the percentage distribution between white and blue collar workers, Table IV-3 was constructed. This shows that the overall differences in average levels among industries has not changed very much. "Other" still uses the largest percentage of white collar workers, which is to be expected given the average size of plant in this sector vs. gold or iron ore. Second, the fall in the rate of growth of white collar workers has not yet had an effect on the relative shares of blue collar workers and white collar workers within industries. In all these cases the relative share of white collar workers continued to rise throughout our study period. This is due to (a) the large drop in blue collar workers which occurred after 1977 and (b) the persistent increase in white collar workers until 1981. It would take large lay-offs of white collar workers to bring the ratios back even to 1977 levels, a process which at the date of publication had already started. The quasi-fixed factor of labour (white collar workers) is still, therefore, an important element determining changes in performance levels. The important question is whether their productivity equals or exceeds wages. Apparently it does not, otherwise it is hard to explain the decline in the number of white collar workers after 1981.

Productivity Change

Table IV-4 and Graph IV-2 set out annual changes in partial and total factor productivity from 1961 to 1984 by selected sub-periods. The updated material is the last two lines covering the period from 1977 to 1984.

With our extended series on partial and total factor productivity, we are able to study the emergence of any patterns in the long run performance of industry. First, labour productivity (Col. 1, Table IV-4), is apparently cyclical, i.e., it does not move monotonically in either a positive or negative direction. Of the five sub-periods shown, labour productivity growth was

Table IV-3

Average Share of Production and Non-Production Workers in the Gold, Iron Ore and "Other" Metal Mining Industries, 1961 to 1984

	Gold		Iron Ore		"Other"	
	L_B	L_W	L_B	L_W	L_B	L_W
	(1)	(2)	(3)	(4)	(5)	(6)
1961-72	.856	.144	.800	.200	.829	.170
1972-75	.842	.158	.818	.182	.745	.255
1975-77	.843	.157	.820	.180	.757	.243
1977-81	.831	.169	.815	.185	.733	.267
1981-84	.820	.180	.781	.219	.719	.281

Source: See Appendix Table 3.

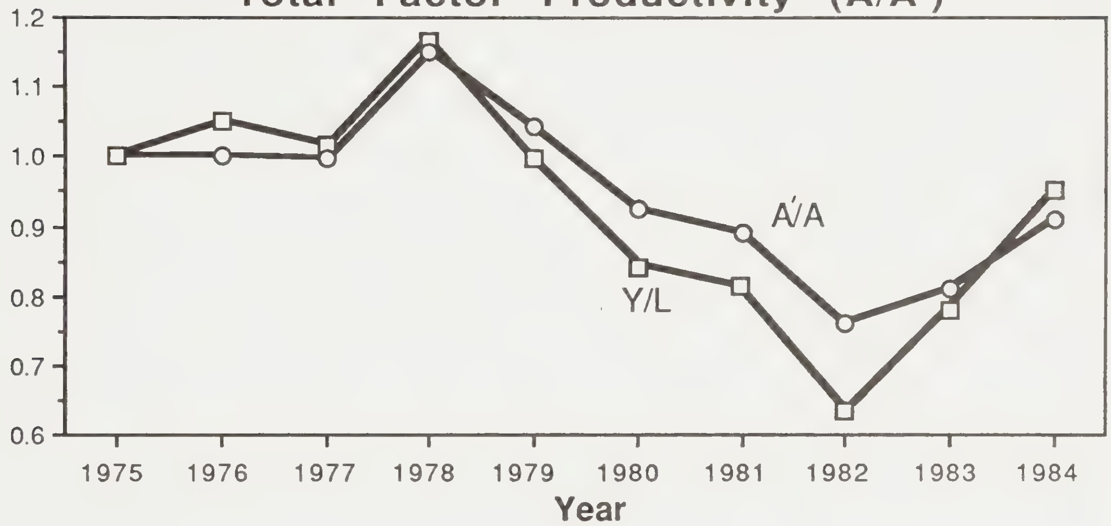
Table IV-4

Annual Movements in Different Measures of Productivity Change, Ontario Metal Mining Industry, 1961-1984

	$\frac{\hat{Y}}{Y}-\frac{\hat{L}}{L}$ (1)	$\frac{\hat{Y}}{Y}-\frac{\hat{L}_B}{L_B}$ (2)	$\frac{\hat{Y}}{Y}-\frac{\hat{L}_W}{L_W}$ (3)	$\frac{\hat{Y}}{Y}-\frac{\hat{K}}{K}$ (4)	$\frac{\hat{Y}}{Y}-\frac{\hat{M}}{M}$ (5)	$\frac{\hat{Y}}{Y}-\frac{\hat{E}}{E}$ (6)	$\frac{\hat{A}}{A}$ (7)
1961-72	3.739	4.644	-0.778	0.820	-2.284	-6.528	0.161
1972-75	-2.826	-2.213	-5.003	4.320	-0.070	-3.988	1.304
1975-77	0.780	0.627	1.288	0.290	0.180	1.225	0.230
1977-81	-4.780	-3.490	-9.180	-8.360	-4.650	2.030	-0.026
1981-84	4.790	3.970	7.010	-7.080	6.350	-1.410	0.111

Source: See Table IV-2.

Graph IV-2
Index of Output Per Worker (Y/L) and
Total Factor Productivity (A′/A)



positive in three (1961-72, 1975-77 and 1981-84) and negative in two sub-periods (1972-75 and 1977-81).

One possible hypothesis for the cyclical behaviour of labour productivity is the movement in real output. The hypothesis suggests that a positive relationship exists between growth in output and labour productivity. Our evidence provides only qualified support for this hypothesis. Thus in the three periods, growth in output per worker was positive, real output growth was also positive in two of these periods (1961-72 and 1975-77) and slightly negative in the third (1981-84). However, for the two periods of negative growth in output per worker, real output growth was also negative (1972-75 and 1977-81). The association between declining output and falling labour productivity suggests that, in the short-run, the adjustment of labour to falling output occurs with a lag. On the other hand one may argue that the same is true when output grows, i.e., labour growth lags behind real output growth so causing labour productivity to increase.

If we break out total labour productivity (Col. (1) of Table IV-4) into its two main components we can see how the overall trends were influenced by employment behaviour of blue and white collar workers. As we saw in Table IV-3 in the share distribution between blue and white collar employees, the former accounted for between three-quarters and four-fifths of total employees. Hence the impact on overall employee performance is heavily influenced by trends in blue collar workers.

The first point to note is that since 1977 productivity of blue and white collar workers followed parallel trends, i.e., both negative from 1977 to 1981 and both positive after 1981. This coincidence of patterns follows the earlier experience of the industry, except for the 1960's when the growth of white collar workers was quite large so generating negative growth rates.

Finally, the swing from negative growth in output per worker between 1977 and 1981 to positive after 1981 saw a larger increase for white than blue collar workers. The implication is that the industry began to trim the number of white collar workers quite severely after the 1982 recession, and that this policy had a positive influence on overall labour productivity.

The change in materials input has been no less spectacular. For three of the four subperiods shown between 1961 and 1981, the growth of materials' productivity was negative. This trend was reversed for the last period - 1981-84, when output per unit of material input grew at over 6.0% a year, second only to the growth of efficiency for white collar workers. Given that materials share in total cost is close to 30% this reversal in trends is important to any explanation of efficiency trends.

Energy productivity trends appear to correlate positively with basic energy price movements. Between 1961 and 1975 when energy was relatively cheap the industry increased its use of this input faster than the increase in real output. Hence energy productivity fell. Between 1975 and 1981 when energy prices rose sharply, severe cutbacks in energy use were made. The result was that output per unit of energy input became positive (Col. 6). Again after 1981 when energy prices began to fall the use of this input increased and productivity declined (-1.41% per year). Although more will be said on this point later in the chapter, it appears that the industry is able to substitute other inputs for energy when the relative price of the latter rises.

Finally a sharp break in the long run trend of capital productivity occurs after 1981. In the previous study we noted that output per unit of capital was consistently positive. However beginning in the early eighties capital investment in the industry increased much faster than output. In fact the two moved in opposite directions. As the number of tons of ore hoisted declined absolutely, capital formation increased. Two things follow from these observations:

(1) capital formation is <u>not</u> related to current output. It appears tied more to long-run decisions which are clearly quite different from short-run production considerations and (2) the present value of net <u>expected returns</u> in the industry, when all appropriate adjustments have been made for tax allowances, etc., apparently exceeds the opportunity cost of capital. It is difficult to justify these high levels of investment if this is not true and future penalties for unwarranted and excessive optimism could be high.

<u>Total Factor Productivity</u> ($\hat{A}$)

Total factor productivity (TFP) has often been described as the measure of our ignorance since, as we described earlier, it is the residual component in the production equation. It is derived, then, by weighing each input by its own factor share and subtracting this weighted total from real output growth. The Index of TFP then measures the contributions of technological change, economies of scale, organization and improvements in worker skills on the observed performance of the industry. Since these four elements are subsumed in the TFP measure we cannot easily assess their respective individual contributions to overall efficiency. However, when an industry is going through major changes in size, or technological adaptation, it is imperative that it be estimated. If say the ratios of labour and capital grew at the same rate over time then we could measure efficiency gains simply by observing trends solely in terms of output per worker.

As one can see (Col. 7, Table IV-4), the long run performance in the industry has been desultory. TFP growth has never exceeded 1.3% per annum and indeed fell to negative rates, i.e., total weighted inputs grew faster than output, between 1977 and 1981. Table IV-5 and Graph IV-3 compare this performance with the growth in total factor productivity for the Canadian economy. Clearly the Ontario metal mining sector, under-performed the Canadian

Table IV-5

Comparison of Growth in Total Factor Productivity
Between Ontario Metal Mining and the Canadian Economy
Selected Periods 1975-1983

	1975-1979	1975-1981	1975-1983
	(1)	(2)	(3)
(1) CANADIAN ECONOMY	-0.3	-0.6	-0.8
(2) ONTARIO METAL MINING	1.1	-1.9	-2.6

Sources:

Line (1) Stuber, Gerald, The Slowdown in Productivity Growth in the 1975-83 Period: A Survey of Possible Explanations, Bank of Canada Technical Report No. 43 (Ottawa, 1986), p. 6.

Line (2) See Table IV-4.

Graph IV-3
Capital - Labour Ratio

economy by a wide margin over the period 1975-83. The gap was not due to the growth in capital stock. The latter grew at 4.4% a year for mining and for the economy.

The annual movements in TFP (Table IV-6) are quite revealing of the problems faced by the Ontario metal mining industry. For the first five years after the 1974 energy crisis overall efficiency in the industry remained fairly stable. The only major deviation was in 1978 when TFP climbed sharply. As far as one can tell from the movement of various input series, the industry, facing what it saw as a further decline in demand cut back on blue collar workers, material inputs and energy plus mine development. For example the number of blue collar workers declined by over 5,000 between 1977 and 1978. The industry was never to regain the level of employment it had experienced in the early 1970's. These input reductions then were much larger than the reduction in output and hence TFP rose sharply in 1978. After this peak in 1978, TFP declined reaching a low of 0.762 in 1982 - the depths of the 1982/83 recession. Subsequently the industry has experienced a gain in TFP. Much of this gain is due to increases in blue collar and material productivity.

Factor Substitution

In the original study, as part of the investigation into the response of the metal mining industry to external input price shocks time trend regressions were run for prices and quantities of inputs employed. These regressions covered the period 1961-77.

The findings for this earlier period were quite straightforward, and conformed to our theoretical expectations. The Ontario metal mining industry substituted capital and energy for labour. This was in conformity with relative cost performance, i.e., labour's cost increased relatively more rapidly than either that of capital or energy. We could make no statement as

Table IV-6

Index of Total Factor Productivity
For the Ontario Metal Mining Industry
Annually, 1975-1984
(1975=100)

1975	1.000
1976	1.001
1977	0.998
1978	1.152
1979	1.043
1980	0.923
1981	0.891
1982	0.762
1983	0.809
1984	0.908

Source: See Table IV-5.

to whether these relative shifts were along the same production frontier, i.e., constant technology or were shifts to a new technology.

Table IV-7 updates these trends for the period 1975 to 1984. The regression coefficients shown in the table are simply the coefficients on the time trend variable for prices and employment. The figures in brackets are the statistical test of significance - here they are t-statistics. A value of 2.0 or greater indicates statistical significance.

An examination of price trends shows, as we would expect, that the price of energy rose faster than any other input, and did so by a wide margin. The next highest was the service price of capital and the main cause of this was the sharp increase in interest rates, early in the period reviewed. The growth in employment is negative except for capital stock which grew at 3.3% a year.

The relationship between relative price change and relative factor usage is not as clear cut for the period after 1975 as it was before this date. Apparently the industry has substituted capital for all other inputs, despite the fact its price growth is second only to that of energy. These results suggest, but do not prove, that technological change since 1975 has been capital-biased.

Another way to look at this process is through the own price elasticity of demand for factors (i.e., capital, labour, etc.). If the own price elasticity of demand is high then it suggests that a rise in the price of the particular factor will induce producers to conserve on its use. They do so by substituting other factors in its place, e.g., capital/labour substitution. A high own price elasticity also means that productivity of the factor should rise sharply as its price rises since, with fixed demand, less of the input is used. Table IV-8 provides a crude set of

Table IV-7

Annual Percentage Changes in the Costs and Employment of Capital, Labour, Materials and Energy Inputs in Ontario Metal Mining 1975 to 1984

(A) COSTS

ΔP_K	ΔP_L	ΔP_M	ΔP_E
16.29	12.85	10.34	29.43
(3.39)	(20.28)	(13.91)	(10.91)

(B) EMPLOYMENT

ΔK	ΔL	ΔM	ΔE
+3.30	-3.30	-2.67	-5.10
(6.47)	(-3.37)	(-2.55)	(-4.82)

Notation:
( ) = T statistics
P_K = service price of capital
P_L = price of labour
P_M = price of materials
P_E = price of energy
K = capital stock
L = labour
M = volume of materials used
E = energy measured in B.T.U.'s

estimates of own price elasticity for capital, labour, materials and energy. These were calculated by dividing the percentage change in quantity (Panel B of Table IV-7) by the percentage change in price (Panel A of Table IV-7).

The results should be treated cautiously. They suggest that the own price elasticity of demand for labour was substantially less than for the other factors. This result is in agreement with the Smithson et al. study.[1] The latter, computed using more sophisticated econometric methods, show elasticities for capital, labour and energy higher than those shown on Table IV-8. However, levels aside, labour's price elasticity of demand is the lowest. These findings suggest that producers "hold-on" to labour more than other factors for a given increase in the price of the factor.

Accounting for Labour Productivity Changes

Labour productivity growth can be shown to be the sum of total factor productivity change (TFP) plus the weighted sum of the growth of inputs relative to the growth of labour. The weights are, in this case, the factor shares for capital, energy and materials. We partitioned labour into blue and white collar workers hence the growth in labour productivity for these two types of workers as well as for total workers can be represented as follows:

$$\frac{\hat{Y}}{Y} - \frac{\hat{L}}{L} = \frac{\hat{A}}{A} + S_K\left(\frac{\hat{K}}{K} - \frac{\hat{L}}{L}\right) + S_E\left(\frac{\hat{E}}{E} - \frac{\hat{L}}{L}\right) + S_M\left(\frac{\hat{M}}{M} - \frac{\hat{L}}{L}\right) \tag{6}$$

1 C.W. Smithson, G. Anders, W. Gramm and S. Maurice, Factor Substitution and Biased Technical in the Canadian Mining Industry, Ministry of Natural Resources, Mineral Policy Background Paper No. 6 (1979).

Table IV-8

Own-Price Elasticity of Demand
For Capital, Labour, Materials and Energy

	Elasticity
CAPITAL	+0.20
LABOUR	-0.08
MATERIAL	-0.25
ENERGY	-0.17

Source: Table IV-7.

$$\frac{\dot{Y}}{Y} - \frac{\dot{L}_B}{L_B} = \frac{\hat{A}}{A} + S_K\left(\frac{\dot{K}}{K} - \frac{\dot{L}_B}{L_B} \right) + S_W\left(\frac{\dot{L}_W}{L_W} - \frac{\dot{L}_B}{L_B} \right) + S_E\left(\frac{\dot{E}}{E} - \frac{\dot{L}_B}{L_B} \right)$$
$$+ S_M\left(\frac{\dot{M}}{M} - \frac{\dot{L}_B}{L_B} \right) \qquad (7)$$

$$\frac{\dot{Y}}{Y} - \frac{\dot{L}_W}{L_W} = \frac{\hat{A}}{A} + S_K\left(\frac{\dot{K}}{K} - \frac{\dot{L}_W}{L_W} \right) + S_B\left(\frac{\dot{L}_B}{L_B} - \frac{\dot{L}_W}{L_W} \right) + S_E\left(\frac{\dot{E}}{E} - \frac{\dot{L}_W}{L_W} \right)$$
$$+ S_M\left(\frac{\dot{M}}{M} - \frac{\dot{L}_W}{L_W} \right) \qquad (8)$$

A word of caution is necessary. These two equations are in a sense accounting identities. They partition changes in total blue and white collar worker productivity into the components shown on the right hand side. Although the right hand side describes annual percentage changes in labour productivity it should not be assumed that there exists a cause and effect relationship which runs in the same direction, since these equations are simply re-arrangements of the basic TFP identity shown earlier (see equation number 3).

Columns (1) - (4) of Table IV-9 sets out the various components of per worker productivity. Before we begin discussion on the implications of our findings it might be useful to point out why the TFP measure is important. If rates of change in capital per worker; energy per worker and material all equalled zero then per worker productivity would equal TFP and there would be no need to measure the latter. We could describe productivity changes solely in terms of output per worker. The first observation is that these ratios do not equal zero and hence we would obtain a misleading picture of productivity change if we only considered per worker output.

Concentrating first on the two sub-periods during which per worker productivity was negative, i.e., 1972-75 and 1977-81, basically the seventies (see Table IV-4), we see that the

Table IV-9

Factors Influencing Growth in Labour Productivity, Ontario Metal Mining Average Annual Growth Rates (in Percentage Points) 1961-1984

	$\frac{\dot{K}}{K} - \frac{\dot{L}}{L}$ (1)	$\frac{\dot{E}}{E} - \frac{\dot{L}}{L}$ (2)	$\frac{\dot{M}}{M} - \frac{\dot{L}}{L}$ (3)	$\frac{\dot{A}}{A}$ (4)	$\frac{\dot{Y}}{Y} - \frac{\dot{L}}{L}$ (5)
1961-72	1.245	0.173	2.052	0.216	3.868
1972-75	-3.318	0.029	-0.892	1.355	-2.826
1975-77	0.195	-0.016	-0.213	0.394	0.780
1977-81	3.58	-6.81	-0.13	-0.026	-4.78
1981-84	11.87	6.20	-1.56	0.111	4.79

Source: See Table IV-4.

causes were quite different over the decade. In the early seventies the decline was due mainly to a slow down in the growth of capital stock relative to the growth in labour, i.e., Col. (1) of Table IV-9 shows a negative growth in capital per worker for the period 1972-75. These differential rates mean capital per worker fell, and this translated into a negative rate of change in output per worker (Col. (5)). We saw in the original study a dramatic shift in capital accumulation between the sixties and seventies - capital accumulation dropped sharply after 1970. This reduction in the capital/labour ratio (see Graph IV-4) which depressed growth in output per worker was partly offset by strong growth in TFP between 1972 and 1975. This increase in total factor productivity, then, partly offset the decline in capital/labour ratios. In the period 1977-81 output per worker is negative. Part of the reason for this is that energy productivity in per worker terms (Col. (2)) declined. The latter was due to the rapid rise in energy prices. Unlike the earlier period, however, the capital/labour ratio rises. This acts to increase output per worker and so offset the negative growth in the other three factors.

If we compare the sixties (1961-72) with the eighties (1981-84), both periods of positive growth in output per worker, the conclusion that emerges is that the factors contributing to the growth in labour efficiency are quite different. In the sixties all the factors grew relative to labour and so made a positive contribution to the growth of output per worker. The latter period showed a negative rate for materials which is offset by very strong growth in capital per worker (Col. (1)) and energy per worker.

Since the sharp rise in energy prices in 1974, there has been a vigorous debate over the effect of this upward price shock on productivity in the economy.[2] One school of thought holds that the increase in energy prices was a major cause of the subsequent decline in productivity.

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2 For an excellent discussion of this debate plus an extensive bibliography, see Gerald Stuber, op.cit.

The position is that capital and energy are complementary inputs, i.e., they move in the same direction for a given change in prices. Hence an increase in energy prices causes producers to use less energy and less capital. The effect of this is to lower the capital-labour ratio and so reduce labour productivity growth. The other school suggests that capital and energy are substitutes and so the capital labour ratio is not reduced as a result of the rise in energy prices. In addition they contend that energy's share in total cost is so small (we found it to be less than 4.0%) that the impact of the higher price was small.

We will not enter this debate but it is worthwhile to see how energy and capital grew relative to one another. The growth of energy per unit of capital is as follows:

	$\frac{\hat{E}}{E} - \frac{\hat{K}}{K}$
1961-72	+ 7.3
1972-75	+ 8.3
1975-77	- 1.0
1977-81	-10.5
1981-84	- 5.4

In the original study we hypothesized that possibly capital and labour were complements since they both grew over the period 1961 to 1975, although capital grew faster. The results from 1975 to 1984 suggest the opposite, i.e., capital and labour may be substitutes. Beginning in the early 1980's the capital stock grew rapidly (Table IV-2) while energy input actually declined from 1977 to 1981 and grew only slightly from 1981 to 1984. More tests will have to be made before we will know whether capital and energy are substitutes or complements in the production process.

Table IV-10 sets out the results of partitioning labour force between blue and white collar workers - again this is an accounting identity which seeks to partition the growth in output per

Table IV-10

Factors Influencing Growth in Production Workers' (B) and Non-Production Workers' (W) Productivity, Ontario Metal Mining Average Annual Growth Rates (in Percentage Points), 1961-1984

(A) Production Workers

	$\frac{\dot{K}}{K} - \frac{\dot{L}_B}{L_B}$ (1)	$\frac{\dot{L}_W}{L_W} - \frac{\dot{L}_B}{L_B}$ (2)	$\frac{\dot{E}}{E} - \frac{\dot{L}_B}{L_B}$ (3)	$\frac{\dot{M}}{M} - \frac{\dot{L}_B}{L_B}$ (4)	$\frac{\dot{A}}{A}$ (5)	$\frac{\dot{Y}}{Y} - \frac{\dot{L}_B}{L_B}$ (6)
1961-72	1.631	0.248	0.248	2.360	0.161	4.644
1972-75	-3.033	0.163	0.044	-0.694	1.304	-2.213
1975-77	0.134	-0.040	-0.022	0.159	0.230	0.627
1977-81	4.87	5.69	-5.52	1.16	-0.026	-3.49
1981-84	11.05	-3.04	5.38	-2.38	0.111	3.97

(B) Non-Production Workers

	$\frac{\dot{K}}{K} - \frac{\dot{L}_W}{L_W}$ (1)	$\frac{\dot{L}_B}{L_B} - \frac{\dot{L}_W}{L_W}$ (2)	$\frac{\dot{E}}{E} - \frac{\dot{L}_W}{L_W}$ (3)	$\frac{\dot{M}}{M} - \frac{\dot{L}_W}{L_W}$ (4)	$\frac{\dot{A}}{A}$ (5)	$\frac{\dot{Y}}{Y} - \frac{\dot{L}_W}{L_W}$ (6)
1961-72	-0.682	-0.903	0.138	0.513	0.161	-0.778
1972-75	-4.329	-0.359	-0.025	-1.600	1.304	-5.003
1975-77	0.398	0.099	0.002	0.394	0.230	1.288
1977-81	-0.82	-5.69	-11.21	-4.53	-0.026	-9.18
1981-84	14.09	3.04	8.42	0.66	0.111	7.01

Source: See Table III-3.

worker, here by type of worker, between changes in inputs and their weighted total, i.e., TFP. Again we should stress the finding that swings in output per worker for white collar workers are larger than for blue collar workers after 1977. This implies that a major re-adjustment in the perceived contribution of white collar workers has been made since the late seventies. It certainly suggests that productivity of white collar workers, as we can see, has increased substantially. For example the annual increase in white collar output per worker is the highest labour productivity advance we observe over the study period.

The key ratios to focus on are in Col. (1) - the relationship between white and blue collar workers and the growth of capital stock. If we follow the approach used in the original study then blue collar workers and capital stock can be viewed as substitutes, i.e., as wages rise relative to the price of capital, the latter are substituted for the former. In the case of white collar workers, the relationship between capital and labour is complementary. This occurs since, as capital stock grows, the production process becomes more sophisticated and hence the number of engineers, draftsmen, technicians, etc., needed must necessarily increase. We should expect, then, to see capital and white collar workers moving in unison, i.e., increases in capital stock and increases in white collar workers moving together, although we would not expect to find an exact match.

The ratio of capital per blue collar worker has indeed grown over time. The relationship between growth in the number of white collar workers and growth in capital stock is mixed. In three of five sub-periods white collar workers grew faster than the capital stock. This is partial confirmation of our suggestion that capital stock and white collar workers are complementary factors in the production process.

In the original study we suggested that part of the reasons for the slowdown in worker productivity was the lagged response of white collar workers to a slower growing capital stock. What we are finding is that some of this adjustment is now taking place. We must ask again whether a new relationship is beginning to emerge in the metal mining industry between capital and other factors of production, especially the component of labour input we have defined as a quasi-fixed factor of production, i.e., the non-production workers. The strong link between fixed capital and quasi-fixed capital (i.e., white collar approaching the status of blue collar workers) appears to be weakening.

Chapter V

PRODUCTION COSTS

The discussion in Chapter IV centered on the relationship between the growth in real output and real inputs (capital, labour, energy and materials). This chapter focuses on unit costs of production, i.e., the cost of various inputs, e.g., the cost of labour (the wage bill) per unit of output where the latter is measured in current prices.

The Cost Function

As we showed in the original study (p. 4), the cost function is the dual, i.e., the exact but opposite side of the input/output relationship discussed in Chapter IV. The cost function takes the following form:

$$C_i = q_i(P_{ki}, P_{li}, P_{ei}, P_{mi}, q_i, t) \qquad (1)$$

i.e., the dual of the production function shown as equation (1) of Chapter IV which relates real output to real inputs where

C_i = the total cost of production for industry i
P_k, P_l, P_e and P_m = the prices of capital, labour, energy and materials
q = output level
t = technological change.

We will examine here only two input costs - capital and labour. As we saw in Table IV-2, these two factors account, on average, for 60% of total cost of production. Much of the remaining cost is accounted for by purchases of materials.

Cost of Capital

The service price of capital is the cost to a firm of using a real dollar's worth of capital in a given year. It depends on depreciation and taxation practices, the opportunity cost of capital, the rate of depreciation and the price of new equipment. The formula for the capital service price used in this study is:

$$p = \frac{1 - u_1 z_1 - u_2 z_2 - u_3 z_3}{1 - (u_1 + u_2 + u_3)} [r_n \bullet q_{n-1} + \partial \bullet q_n]$$

where

u_1 = federal income tax rate;

u_2 = provincial mining tax rate;

u_3 = provincial income tax rate;

z_1 = federal depreciation allowance (use the declining balance formula $d \bullet \frac{r+1}{r+d}$, where d is the depreciation rate set in tax laws);

z_2 = provincial mining tax depreciation allowance (use the straight-line formula $\frac{1}{r\ell}\left[1 - \left(\frac{1}{1+r}\right)^{\ell}\right]$ is used where ℓ is the lifetime allowable for tax purposes).

z_3 = provincial income tax depreciation allowance (use $d \bullet \frac{r+1}{r+d}$. This allowance existed only after 1976 and, thus, before 1976 d = 0, which results in $z_3 = 0$);

r = corporate bond yield rate;

q = index of deflating investment;

∂ = depreciation rate (i.e., $\frac{1}{\text{service life}}$);

n = year.

Source: D.W. Jorgenson, "The Measurement of U.S. Real Capital Input, 1929-1967", The Review of Income and Wealth, Series 15, No. 4, December 1969. and

R.E. Hall and D.W. Jorgenson, "Tax Policy and Investment Behaviour", American Economic Review, Vol. 57 (June 1967), pp. 391-414.

Table V-1 and Graph V-1 show (a) the service price of capital (defined above); (b) capital stock in the Ontario metal mining industry; and (c) the total cost of capital. The latter is derived by multiplying the annual service price of capital by the stock of capital. The cost of capital, then, represents how much a producer must pay for the annual use of his machinery and buildings. It is the capital equivalent to the cost of labour. The cost of labour is referred to as the wage bill and is the sum of wages and salaries paid to a companies' employees which includes indirect labour costs.

The first point to note is that the service price of capital has jumped by 72% between the late seventies and early eighties. Two factors account for this increase. Corporate bond rates increased from an average of 11% in the late seventies to between 13 and 15% in the 1982's, although they eased back slightly after 1984. The other factor is the sharp rise in the price of new capital goods. Between 1980 and 1985 the price of such goods rose from an index level of 230.6 in 1980 to 291.3 in 1985 or an increase of 26% in five years. Capital investments made recently, therefore, have been undertaken at a steeply rising cost to the industry. It is worth mentioning that none of the major tax rates changed during the last few years.

Col. (2) (Table V-1) shows the growth of real capital stock. As we mentioned earlier, the dynamic element in the industry since the late seventies has been the sharp increase in investment in the industry. Investment levels which were running at between 400 and 700 million dollars a year from 1975 to 1979 jumped to between 900 million and a billion dollars a year in 1985. This increase in current investment is translated into a

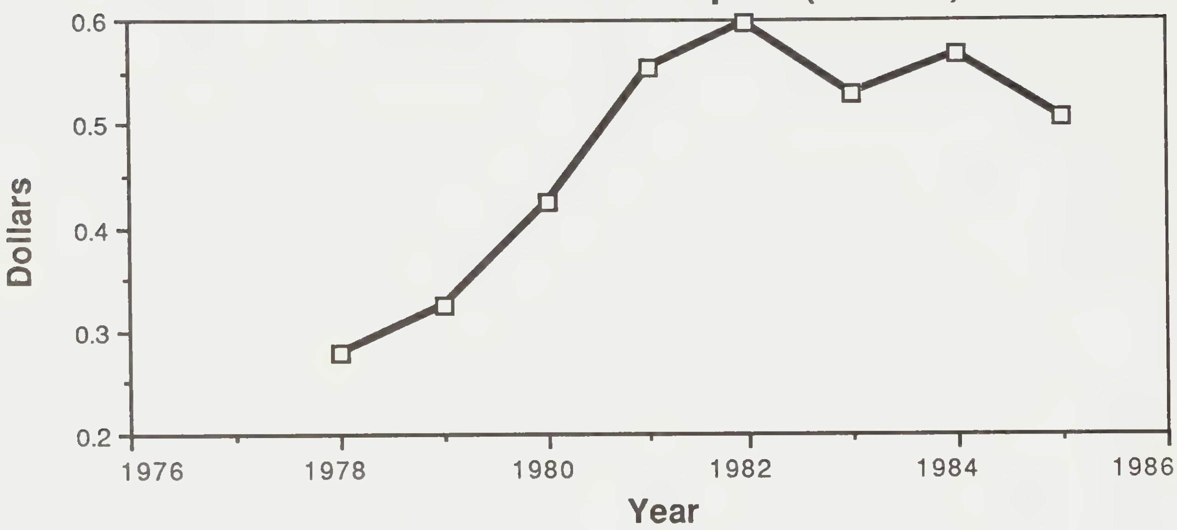
Table V-1

Service Price and Cost of Capital
Ontario Metal Mining, 1978-1985

	Service Price (1)	Real Capital Stock (2)	Cost of Capital (1)x(2) (3)
1978	.278	1,872.78	520.63
1979	.324	1,897.31	614.73
1980	.425	1,998.00	849.15
1981	.555	2,087.32	1,158.46
1982	.597	2,141.97	1,278.76
1983	.529	2,253.56	1,192.13
1984	.568	2,482.70	1,410.17
1985	.507	2,664.97	1,351.14

Source: Appendix Table 2.

Graph V-1
Service Price of Capital (Dollars)



rapid growth in real capital stock. Between 1978 and 1985 capital stock increased by 42%, most of this growth occurring in the eighties. The combination of increased size of the capital stock and increased service cost is translated into higher cost of capital to the sector (Col. (3)). A large jump in these costs is simply the joint result of these other trends.

This steep rise in the service price of capital (see Graph V-1) and in its counterpart the total cost of capital raises an interesting question about the forces driving this industry. As we saw in Chapter IV the huge increase in capital stock in the Ontario metal mining industry during the eighties has not been matched by an increase in the growth of real output (ore hoisted). The result of this is that capital productivity (output per unit of capital - Table IV-4) has fallen. Thus over the period 1977-81 the output per unit of capital fell at an annual rate of 8.4% and between 1981 and 1984 at a rate of 7.1%.

How can one explain these findings - higher cost of capital; falling real (although not nominal output) output and an investment boom? The industry has apparently gone on a capital binge. Whether this is a reaction to steeply rising real product wages or to higher energy costs is not known. There does appear, however, to have been a shift in the nature of the production process towards greater capital intensity. On the short-run this has led to negative or low rates of growth of total factor productivity in the eighties (Col. (7), Table IV-4). A positive light can be thrown on this capital boom if one sees it as a precursor to an expected resource boom in the nineties. Capital is being put in place today to meet larger demand and higher metal prices expected by the industry in the next decade. Higher real metal prices constitute the crucial assumption.

Average Labour Costs

The total cost of labour (labour's factor share) is the product of average wage multiplied by the number of employees. As we saw in Table IV-1 labour's factor share rose from 21.3% in the period 1975-77 to 23.2% in the period 1982-84. While the number employed in the industry declined from 28,671 to 23,304 over this period.

The main factor increasing labour's factor share, then, must have been an upward trend in average wages. Table V-2 sets out, in index form, the trends in per worker compensation for total workers and those in the combined gold and iron sector and for "other". It was necessary to combine gold with iron ore production since estimates of employment in the iron ore industry were not published for 1978 and 1979.

The trends reveal an interesting difference among the sectors. Before 1977 the gold and iron ore sector showed a much higher rate of growth in average wages than did the "other" sector. In the eighties for which we have evidence on all three sectors the rate of change shifts slightly from gold and iron to "other", i.e., the former rises by 48.5% while the latter increases by 49.5%. The lesson we learn is that, although levels of compensation may differ, the rate of growth in average wages is about the same across the industry. Differences that are observed may be due to different overtime earnings among the industry. Nevertheless it appears that both declining (iron ore) and rapidly expanding industries (gold) experience about the same rate of wage growth. The impact, of course, on the industries is very different.

An area of concern in this as in the previous study is the wage-productivity nexus. Did real product wages increase at a different rate from productivity? Since we are as-

Table V-2

Index of Compensation per Employee in the Ontario Metal Mining Industry For Gold and Iron, "Other" and Total, 1975-1984
(1977 = 100)

	Total	Gold and Iron Ore	"Other"
1975	82.21	75.27	84.80
1976	92.34	89.55	93.27
1977	100.00	100.00	100.00
1978	120.14	------	------
1979	135.26	------	------
1980	146.84	140.08	149.21
1981	165.18	152.39	172.58
1982	172.59	177.19	172.16
1983	192.50	185.52	194.30
1984	219.49	207.96	223.46

Source: See Appendix Table 4.

suming a Cobb-Douglas production function then average product of labour should equal real wage since $AP_L = MP_L$ (where $AP_L =$ average product of labour and $MP_L =$ the marginal product of labour).

Table V-3 sets out, in index form, the relationship between average product of labour and real product wages (nominal wages divided by product wages) and shows our results for the earlier period. It is clear that the trend established in the 1970's continued into the 1980's, i.e., product wages increased faster - much faster now, than did productivity. The relationship between wages and productivity using the Cobb-Douglas form of the production function is:

$$\dot{W} = B + \dot{A} + \dot{P}$$

where W = nominal wage rate; B = labour's factor share; A = total factor productivity and P = metal prices. All values are expressed in terms of rates of change.

If real wages ($\hat{W} - \hat{P}$) rise faster than $\hat{A}$ (total factor productivity) then $\hat{B} > 0$. The reverse occurs if productivity rises faster than real wages. As we saw above, real wages are rising much faster than productivity hence labour's factor share should be rising. This is exactly what we found (see Table IV-2); labour's factor share rose 15% from the mid 1970's to the mid 1980's, again continuing a trend started in the seventies.

Finally the effect of having product wages grow faster than productivity is important for the industry. It implies that there has been a redistribution from capital to labour. The case for such a re-allocation within this industry is even stronger if we included indirect (i.e., holiday pay, vacations, insurance, etc.) with direct labour costs (take home

Table V-3

Index of Average Product of Labour and Average Real Wage, 1978 to 1984
(1979 = 100)

Year	Average Product of Labour	Average Real Wage[1]
	(1)	(2)
1978	------	116.64
1979	100.00	100.00
1980	84.50	103.74
1981	81.60	146.29
1982	63.70	188.19
1983	78.40	211.03
1984	95.70	249.37

NOTES: (1) Real wage was obtained by dividing nominal wages by an index of metal prices (including gold).

(2) Indices for these two variables for the early period are as follows:

	Average Product of Labour	Average Real Wage
	(1971 = 100)	
1961/62	59.6	81.68
1969/70	96.8	84.12
1976/77	99.3	95.46

Source: Mineral Policy Background Paper No. 19.

income). This redistribution in factor incomes is presented as an hypothesis rather than as an established fact.

Cost of Capital Relative to the Cost of Labour $\left(\frac{P_K}{P_L}\right)$

The trend in the relative cost of capital (P_K) to the direct cost of labour (P_L) is shown in Table V-4. This index was calculated by dividing an index (1981 = 100) of the service price of capital by an index of average compensation of labour. The trend over time in the index itself is the relevant feature here, not the level of the derived index.

The trend in relative price of capital to labour is quite interesting. Over the whole period, i.e., 1978 to 1984, the price of capital, measured as its service price has risen relatively to the price of labour. The trend, however, has not been monotonic. After a steep rise in the relative price of capital in the late seventies, i.e., from 0.618 in 1978 to 1.06 in 1982, the trend was reversed and in the eighties the price of labour has risen relative to the price of capital. Overall, however, the price of capital has risen relative to the price of labour; economic theory predicts that firms would substitute labour - the relatively cheaper factor - for capital over time. This is not what has happened. As we noted earlier the capital/labour ratio has indeed risen over the study period. In 1975 it was 64.3 while in 1984 it had climbed to 106.5.

This upward trend in the relative price of capital after 1978 follows the path set between 1967-65 and 1971-79. In the earlier period the price of capital increased faster than the price of labour, i.e., from 100.00 between 1967-75 to 117.6 in the final period. Although it is impossible to link this latter index to our index, nevertheless there is the strong suspicion from our data that this upward trend in the $\frac{P_K}{P_L}$ ratio has continued for

Table V-4

Index of the Price of Capital Relative to the Price of Labour, For Ontario Metal Mining, 1978-1984
(1981 = 100)

Year	$\frac{P_K}{P_L}$
1978	0.618
1979	0.647
1980	0.824
1981	1.000
1982	1.056
1983	0.883
1984	0.916

Source and Methods: See Text.

almost twenty years. This upward trend would be modified slightly if indirect labour costs were included in the price of labour.

We have three statistics that must be reconciled - rising relative price of capital, an increase in the share of capital cost in total cost and the finding that there is a low degree of substitutability between capital and labour.[1] Thus with low capital/labour substitutability we would expect to see capital's factor share rising and labour's factor share falling if $\frac{P_K}{P_L}$ is rising. The implication, not tested here, is that for these two factors the technology of the industry limits flexibility, i.e., the underlying production function is not Cobb-Douglas in form. If it were Cobb-Douglas then factor shares would remain constant with relative price changes since the rate of substitution is assumed equal to one.

Unit Costs of Production

The unit costs of production are derived by summing all input costs and dividing this total into total revenue (gross value of production). The counterpart or dual for the production function (p. 58) would produce costs for each level of output and an index of efficiency. We have not gone through this calculation. Unit costs for the period 1975 to 1984 are shown in Table V-5 and Graph V-2.

Table V-5 confirms our earlier findings regarding the sharply increased costs of capital and labour. Unit costs of production increased by 38 index points from 1977 to 1984. They went as high as 173 index points in 1982, i.e., during the great recession. The run up of the latter was due to the sharp drop in revenue which, in the short-run, could not be fully compensated for by a drop in costs. The sharp increase in unit costs would

1 See the original study (Policy Background Paper #19, p. 12).

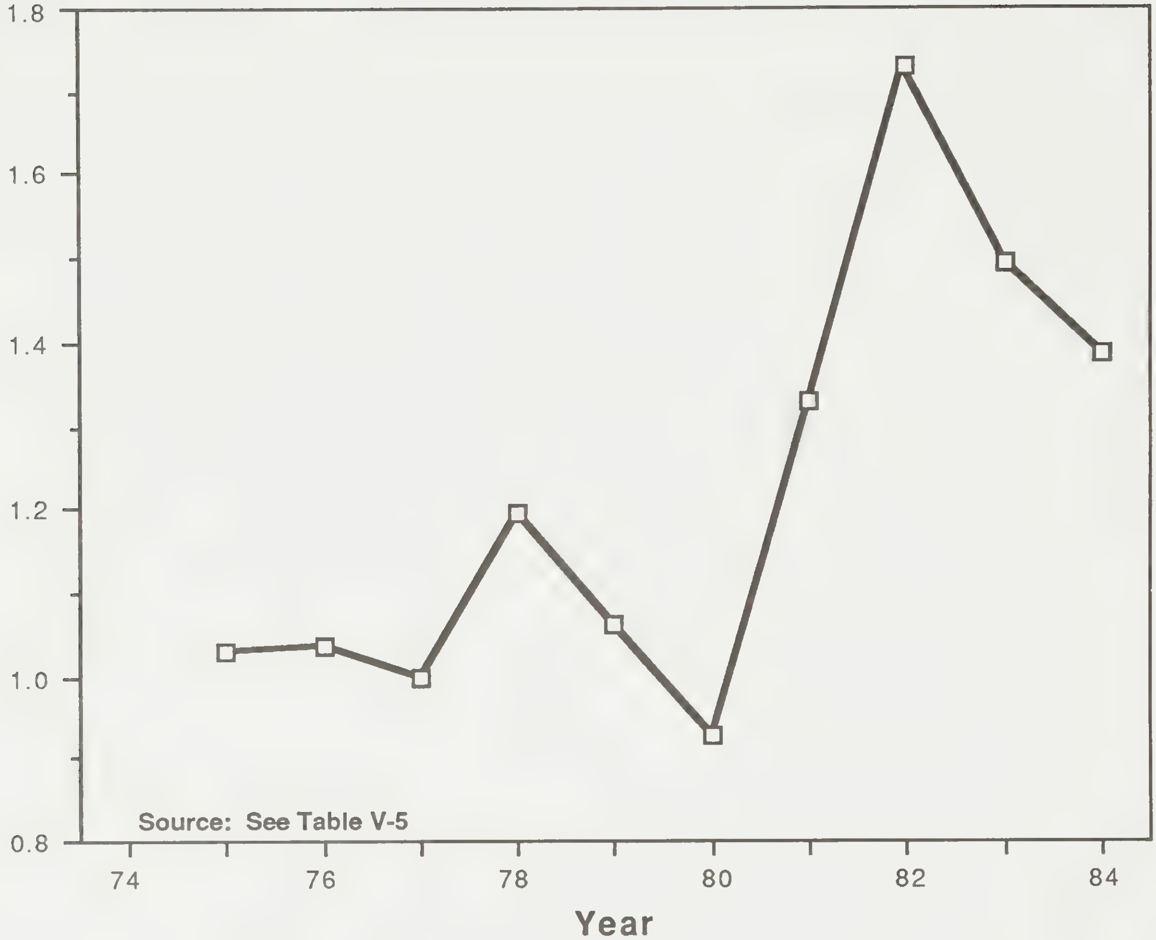
Table V-5

Index of
Unit Costs of Production
1975-1984
(1977 = 100)

Year	Unit Cost
(1)	(2)
1975	103.02
1976	103.57
1977	100.00
1978	119.37
1979	106.18
1980	92.99
1981	132.55
1982	173.08
1983	149.73
1984	138.60

Source: See Appendix Table 1.

Graph V-2
Index of Unit Cost of Production
(1975-1984)
(1977 = 100)



be modified somewhat if we had included efficiency gains. However, as we saw earlier, the change in TFP was small. Hence the conclusion here is that the metal mining sector was becoming a more costly industry. Part of the increase in these costs was due to the heavy capital investments made after 1980.

Chapter VI

THE COST OF LABOUR

In the original study we raised the question as to whether the price of labour, i.e., average wage per employee was the true cost of labour. The question was raised in connection with the correct measure of total factor productivity ($\dot{A}$). If the true cost of labour is different from its price then the measure of $\dot{A}$ will be biased either upward if the price is less than the cost or vice versa if the inequality runs the opposite way. Our investigation suggested that indeed the cost of labour exceeded the price of labour - the difference was indirect labour costs (i.e., workmen's compensation, pensions, etc.).

In this updated version we seek answers to the questions (a) has the gap between the price of labour and the cost of labour changed since our last observation in the original study, i.e., 1979? (b) Has there been any significant deviation in the gap between the price and cost of labour between the mining and manufacturing sectors over the last decade?

Definitions

(a) Direct Wages

Direct wages or compensation are defined as pretax wages that accrue to the worker as a result of hours actually worked (Ostry and Zaidi, p. 198).[1]

(b) Indirect Compensation

Indirect compensation covers pay for time not worked, e.g., vacations, holidays, etc.; payments required by law such as workmen's compensation, unemployment insurance, etc.; benefit plans which include private pension plans, group insurance, etc.; and bonus and profit sharing payments.

(c) Gross Payroll

Gross pay is the total organizational payroll. As such it consists of straight time pay which is composed of "wages and salaries for time worked and for time not worked if wages and salaries are normally paid while an employee is on vacation, taking holidays, sick leave, etc. (pay for time not worked)". Also included are premium payments which are payments in excess of straight time pay, for overtime shifts, holidays, etc., incentive and production bonuses but not organization bonuses such as profit sharing plans, and finally other direct wage and salary payments such as isolation pay". [Employee Benefit Costs in Canada, 1984, Thorne, Stevenson and Kellogg, Management Consultants, p. 8].

1 Ostry, S and M. Zaidi, Labour Economics in Canada, 3rd ed., Macmillan, 1979.

Defined in this way gross payroll is greater than the direct wage for labour which, as defined above, consists only of pay for time worked.

<u>**Direct Labour Costs (Gross Payroll)**</u>

Direct labour cost in this study refers to the items included in gross payroll (see above) and as such these differ from direct wages. The latter refers only to wages that accrue to the worker for hours actually worked (i.e., paid for time worked).

Table VI-1 compares the growth in gross payroll per employee as recorded in the sample of Ontario metal mining firms with the same for manufacturing firms (Thorne, Stevenson, Kellogg).[2] The results are most revealing. First the average level of gross payroll per employee in the mining sector in Ontario is higher than in manufacturing. This higher level of compensation may reflect a different, and higher, capital labour ratio in mining than exists in manufacturing. Second, over comparable years, i.e., 1980 to 1984, average gross payroll in mining grew faster than in manufacturing. Given the poor international markets for metals during these years this growing divergence in average compensation is difficult to explain. Finally note that at the depths of the recession, 1982, gross payroll per employee in mining declined relative to manufacturing (see Col. (3)). This reflects the impact on the mining sector of depressed foreign demand for metals in this year. These levels in compensation per employee will be used to standardize other forms of employee compensation and hence changes in these levels will become an important element in explaining trends in some of the other compensation variables.

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2 Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada, biennially.

Table VI-1

Trends in Gross Payroll per Employee in Ontario Metal Mining[1] And In Canadian Manufacturing, 1980-1985

	Ontario Metal Mining (1)	Canadian Manufacturing (2)	Ratio (1) ÷ (2) (3)
	A (LEVEL)		
1979	17,841	n.a.	----
1980	22,764	20,409	1.12
1981	24,312	n.a.	----
1982	23,299	21,625	1.08
1983	26,944	n.a.	----
1984	31,642	26,910	1.18
1985	34,159	n.a.	----
	B (PERCENTAGE CHANGE)		
1980-84	39.0	31.9	

Source: Col. (1) Figure drawn from sample survey of Ontario Metal Mining firms.

Col. (2) Thorne, Stevenson and Kellog, Employee Benefit Costs in Canada, Various issues.

Note: n.a. = not available

Before moving to a comparison of indirect and direct labour costs we should examine how the trend in average direct labour cost moved vis a vis two price indices - the consumer price index and the metals price index. Deflating nominal compensation by the former provides us with a measure of the real purchasing power of workers in the industry while the latter is a measure of real product wage. Between 1980 and 1984 the Consumer Price Index (CPI) increased by 37.6% while the metals price index decreased by 37.8%. Real purchasing power (nominal wages divided by C.P.I.) increased then for workers in this industry (by 1.4%) and real product wages (nominal wages divided by metal prices) increased by (76.8%). The latter is critical to our analysis since it suggests a strong incentive for capital labour substitution (see Chapter V).

Indirect vs. Direct Labour Costs

In the original study (Table IV-1, p. 94) the ratio of indirect to direct labour costs increased dramatically for mining and manufacturing. In the Ontario metal mining industry the share of indirect to direct was 16.3% in 1961 and by 1977 it had climbed to 43.9%. The comparable figures for Canadian manufacturing were 23.4% and 32.1% respectively. By the late seventies, then, metal mining had caught up and surpassed the manufacturing sector in terms of relative indirect labour costs.

The ratios for the 1980's are shown in Table VI-2. The estimates for Ontario metal mining are taken from our sample of mining companies. The first point to note is that the upward trend in the share of indirect labour costs has ceased. In both the mining and manufacturing sectors the ratio has stabilized near 33%. Second, both sectors show

Table VI-2

A Comparison of Fringe Benefit Outlays Between Ontario Metal Mining and Canadian Manufacturing Sector, 1979-1984

	Ontario Metal Mining (1)	Canadian Manufacturing (2)
1980	35.1	31.5
1982	44.9	31.8
1984	33.3	33.8

Source: Col. (1) See Appendix Table 5.

Col. (2) Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada, 1980, 1982 and 1984.

Note: Fringe benefit costs are taken as a percentage of gross payroll.

about the same level of indirect labour costs. Thirdly the mining sector shows a distinct cyclical aspect in its share of indirect labour costs.

The cyclical pattern for mining arises from the interaction of (a) the nature of the industry and (b) the relative short-run invariance in indirect labour costs. Let's take each point in order. The mining industry is highly cyclical. It is the case that the amplitude of variation in output is greater at the raw material end of the production process than at the finished product end. We see this clearly in Table VI-2 where 1982 is a year of deep recession and the share of indirect labour costs increases to 44.9%. An examination of the records reveals that, gross payroll for most firms but even more so for the larger ones, dropped quite substantially due, one suspects to lay-offs and shorter working time.

The ratio for mining of indirect to direct labour costs rises sharply in 1982 due to the joint effect of a smaller gross payroll resulting from lay-offs and shorter working times, and a relative fixed set of indirect payments. Apparently indirect labour payments are the cost counter part to quasi-fixed factors of production referred to in earlier chapters. In the short-run this is not an unreasonable interpretation. For example short term and temporary lay-offs, although they decrease gross payroll do not have a large downward effect on such indirect payments as holiday or vacation pay. Some employers agree to carry on pension and health care plans if the individual is expected to return to full or partial employment within a short period of time.

The most important discovery, however, is the relative constancy in the share of indirect to direct labour cost. It suggests, but does not prove, that at the margin workers' preferences are about balanced as to whether an extra dollar of income will go towards

direct take-home pay or go to build up insurance or pension entitlements. Whether the tax incentives for this type of trade-off are less allocative is one possibility or whether the workers have shifted, with higher real interest rates, their time rate of preference towards the present (i.e., the value of future dollars falls to low levels over a short period of time), is not known. Whatever the reason there is now an apparent equilibrium on extra dollars of income between direct and indirect compensation.

The actual allocation is of course the net outcome of bargaining between employers and their employees. As we mentioned in the original work there are strong incentives for the employer to favour indirect over direct payments. They are:

(i) the need to schedule work to avoid production interruptions. Hence the benefit of clearly defined vacation times.

(ii) Employee benefit plans, pensions, dental plans, etc., are seen as valuable partly due to the benefits themselves and partly due to tax savings by the employees which occur with these benefits. They may also be seen as a lock-in device by the employer. Both of these factors, then, have a positive effect on productivity. The latter adds a further incentive for the employer to support larger benefit pay outs from a given increase in base pay. The finding here that indirect wages have stopped growing relative to direct wages implies that at the margin the employer, as well apparently as the employee, is relatively indifferent about whether wage increments should go to take home pay or be assigned to benefit programmes.

How did indirect to direct wage payments movement vary among the different metal mines? Table VI-3 sets out this ratio for gold and iron mines combined and "other". The latter includes copper, nickel, lead, etc., producers. The first point to note is that

Table VI-3

A Comparison of Direct to Indirect Labour Costs
For Gold and Iron, and "Other" Metal Mines in Ontario
1979-1985

(A) GOLD AND IRON

1979	25.9
1980	25.6
1981	25.7
1982	26.4
1983	26.0
1984	29.2
1985	30.5

(B) "OTHER"

1979	30.7
1980	36.2
1981	35.1
1982	47.1
1983	29.5
1984	33.8
1985	34.3

Source: Appendix Tables 6 and 7.

the indirect to direct benefit ratio is lower for gold and iron production than for "other". An examination of the individual company replies to our sample survey suggests that smaller producers generally offer fewer benefit packages to their employees than do larger producers. This suggests that in the trade-off between more benefits and the potential productivity gain, as discussed above, it does not "pay" for smaller employers to introduce large scale retirement plans, health insurance, etc. It is probably the case that smaller producers do not expect to be in operation for a long period of time vs. large producers like Inco, Falconbridge, etc. If this is the case then we should expect to find that direct pay, i.e., pay for time worked per employee, is higher in small vs. larger mining operations. Thus in 1981 the average wage per employee, on a pay for time worked basis, in the "other" category (dominated by larger producers) was $21,387. For the combined mining groups of iron and gold (smaller firms) the average was $27,702. This may be due to the fact that these figures have been dominated by new small gold mines.

Finally, Table VI-3 shows that for "other" a slight fall in the level of indirect to direct labour costs is observed between 1980 and 1985 while for iron and gold the ratio rises from 25.6% in 1980 to 30.5% in 1985. This may be explained in part by the fact that during mine expansion periods younger employees move to new mines where bonus payments are higher and fringe benefits are not as high. The latter are of more value to families whereas younger miners are often single. The steady level of indirect to direct labour costs shown in Table VI-2 then is a weighted average of these two trends. The larger companies have sought, as part of their cost effectiveness programmes to save on indirect payments while as the smaller gold companies grew in size they apparently took on some of the benefit plans that were a feature of the larger firms in the industry. If the

analysis above is correct this would suggest that average wage payments per employee on a pay for time worked basis should have converged over time. This is indeed what happened. In 1984 average direct wages in the "other" group were $27,999 while for gold and iron they were $27,692, virtually identical.

Distribution of Indirect Wage Payments

To obtain a clearer picture of the factors influencing the trend in indirect to direct wage payments, the various components of the latter have been broken out into their sub parts. They are shown both as a percentage of gross payroll, Tables VI-4 and VI-5, and by level per employee Tables VI-6 and VI-7. A comparison is made between total metals for Ontario and Canadian manufacturing and within metal mining between the combined categories of gold and iron ore and "other".

Table VI-4 shows the relative levels of various types of benefits for metal mines and Canadian manufacturing, relative to gross payroll. The first point to note is that for both mining and manufacturing the various series show virtually no trend between 1979 and 1985. Indirect labour costs, therefore, have grown at about the same rate as gross payroll. This finding holds across all categories of benefits, i.e., paid time off, payments required by law, etc. This is an important finding since these ratios had climbed quite substantially during the sixties and seventies (see the discussion in the previous section).

The second point to note is the difference in levels of benefit costs per dollar of gross payroll between mining and manufacturing. As we outlined in the previous section indirect labour costs were higher than in manufacturing, as a share of gross payroll. Table

Table VI-4

Indirect Labour Costs As Percentage of Gross Payroll
Ontario Metal Mining and Canadian Manufacturing
1979-1985

(A) ONTARIO METAL MINING

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	8.0	1.0	10.9	9.5	29.4
1980	11.0	1.0	7.5	15.6	35.1
1981	11.1	1.0	7.8	14.2	34.1
1982	12.8	1.3	8.3	22.6	45.0
1983	11.2	1.6	8.5	14.3	35.5
1984	10.4	1.2	9.7	12.0	33.3
1985	10.5	1.6	10.0	11.9	33.9

(B) CANADIAN MANUFACTURING

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	n.a.	n.a.	n.a.	n.a.	n.a.
1980	12.9	2.9	3.8	10.5	31.5
1981	n.a.	n.a.	n.a.	n.a.	n.a.
1982	13.3	3.2	4.1	9.7	31.8
1983	n.a.	n.a.	n.a.	n.a.	n.a.
1984	14.8	3.8	4.6	9.4	33.8
1985	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Panel A: See Appendix Table 5.

Panel B: Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada, 1980, 1982 and 1984.

Table VI-5

Percentage of Indirect Labour Costs to Gross Payroll By Category for Gold and Iron, and "Other". Ontario Metal Mines, 1979-1985

(A) GOLD AND IRON

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	7.4	1.5	10.8	6.2	25.9
1980	7.2	2.1	9.8	6.4	25.6
1981	7.2	2.0	10.4	6.1	25.7
1982	8.1	1.8	10.3	6.2	26.4
1983	7.8	1.7	10.5	5.9	26.0
1984	7.8	1.7	12.5	7.2	29.2
1985	8.8	3.0	12.4	6.3	30.5

(B) "OTHER"

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	8.2	0.9	10.9	10.7	30.7
1980	11.5	0.8	7.2	16.7	36.2
1981	11.5	0.9	7.5	15.1	35.1
1982	13.3	1.2	8.1	24.4	47.1
1983	11.6	1.6	8.2	15.3	36.7
1984	10.7	1.2	9.4	12.6	33.8
1985	10.7	1.5	9.6	12.6	34.3

Source: See Appendix Table 5.

VI-4 shows that virtually all this difference is accounted for by negotiated benefit plans, i.e., pensions, insurance, health plans, etc. Paid-for-time off, i.e., vacations and holidays account for roughly the same percentage of gross payroll in both sectors. It is interesting to note that "paid time off" is the most expensive indirect labour cost. This suggests that some arrangement whereby management and employees share benefits of not taking so much time off could be derived.

Do workers in mining, then, trade-off higher indirect wages (benefits) for lower average take-home pay than employees in Canadian manufacturing? Apparently they do not. Average gross payroll in manufacturing per employee was 20,409 in 1980 and 26,910 in 1984. In iron and gold mining the averages were 27,702 and 27,692 and in "other", 21,387 and 27,999 respectively. Mine workers sampled had slightly higher take-home pay in both years, although the difference between mining and manufacturing was really quite small. One cannot automatically assume that mining labour costs per unit of output are higher for mining than for manufacturing as is implied in this comparison. It could be that mining uses non-labour inputs more efficiently than does manufacturing. It does suggest, however, that mine workers are able to bargain for higher benefits than their counterparts in manufacturing. If we can assume that the work is more dangerous in mining than in manufacturing then part of the difference is only a reflection of what Adam Smith called the "net advantages" factor for selling wage levels. The "net advantage", all other factors equal, is with manufacturing. Hence, in total, mining must pay more, in some form - direct vs. indirect, to attract workers to the sector.

Table VI-5 shows a similar break-down of indirect labour costs as in Table VI-4 except here we compare the gold and iron ore group with "other". Again the measure is

cost of benefits divided by gross payroll. If we view this comparison not only as groups of miners producing different commodities but of industries grouped by different average size plants we come up with some interesting insights.

Of the benefits which we might say are earned by negotiation (vs. required by law), i.e., 'paid time off" and "benefit plans", the gold and iron mines costs per dollar of gross payroll are smaller. For "paid time off" the firms listed under "other" pay 2-4 percentage points more than do the smaller gold and iron producers. For benefit plans the gap is much more spectacular. "Other" mines absorb almost twice the cost per dollar of gross payroll than do firms in gold and iron sectors. On the other hand the "payments required by law" are anywhere from 2-3 percentage points higher in gold and iron than in "other".

What explanations can we offer? First the higher "paid for time off" cost for "other" may reflect accumulated holiday leave entitlements in firms where employees have worked for one employer for a long time. This type of long run attachment is not so prevalent in the small gold mine firms. Second the higher payments under the category "required by law" for gold and iron may reflect higher possible risks associated with being a miner in these firms than in the larger copper, nickel and zinc companies. Finally the larger "benefit plans" cost per dollar of gross payroll must be like "pay for time off". Larger, older firms in "other" have more accumulated benefit liabilities, for example, in pension costs than do the smaller and possibly newer gold mines. Thus a shift in gold from older to newer mines may account for some of this decline.

Tables VI-6 and VI-7 show the dollar cost of various benefits expressed in per employee terms. Looking first at Table VI-6 we see that for Canadian manufacturing total

Table VI-6

Levels - Indirect Labour Costs Per Employee
Ontario Metal Mining and Canadian Manufacturing
1979-1985

(A) ONTARIO METAL MINING - TOTAL

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	1,430	188	1,884	1,660	5,162
1980	2,509	217	1,695	3,554	7,976
1981	2,712	247	1,893	3,473	8,324
1982	2,923	306	1,901	4,667	9,797
1983	2,969	462	2,252	3,683	9,365
1984	3,282	386	3,035	3,751	10,454
1985	3,758	600	3,501	4,147	12,007

(B) CANADIAN MANUFACTURING

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	n.a.	n.a.	n.a.	n.a.	n.a.
1980	2,447	292	657	2,073	6,037
1981	n.a.	n.a.	n.a.	n.a.	n.a.
1982	3,084	297	857	2,262	7,183
1983	n.a.	n.a.	n.a.	n.a.	n.a.
1984	3,995	295	1,198	2,638	9,228
1985	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Panel A: See Appendix Table 5.

Panel B: Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada, 1980, 1982 and 1984.

Table VI-7

Levels - Indirect Labour Costs per Employee
Gold and Iron, and "Other" Metals
1979-1985
(dollars)

(A) GOLD AND IRON

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	1,317	316	1,835	1,154	4,622
1980	1,538	463	2,044	1,386	5,431
1981	1,638	463	2,316	1,398	5,813
1982	2,206	514	2,747	1,749	7,216
1983	2,178	518	2,820	1,704	7,219
1984	2,397	538	3,759	2,239	8,933
1985	2,787	1,045	3,839	2,026	9,698

(B) "OTHER"

Year	Paid Time Off (1)	Other (2)	Required By Law (3)	Benefit Plans (4)	Total Indirect (5)
1979	1,471	141	1,904	1,847	5,363
1980	2,619	190	1,656	3,798	8,262
1981	2,834	222	1,845	3,709	8,610
1982	3,005	281	1,803	5,003	10,093
1983	3,064	455	2,183	3,923	9,625
1984	3,394	367	2,944	3,942	10,647
1985	3,876	546	3,460	4,404	12,286

Source: See Appendix Table 5.

indirect costs per employee are lower than for Ontario metal mining. The ratio (manufacturing ÷ mining) is .75, .73 and .88 for 1980, 1982 and 1984 respectively. Indirect labour costs per employee then are rising faster for manufacturing relative to mining. One suspects this increase is more related to rationalization in the mining sector than to accelerating benefit costs in manufacturing. The mining industry over the last four or five years has made a conscientious effort to reduce its labour costs through lay-offs, early retirement, etc. These latter policies have an important affect on indirect labour cost per employer, i.e., a younger labour force is less costly per employee in terms of life insurance and pension cost than an older labour force.

If we turn now to Table VI-7 and the comparisons within the mining sector the difference in indirect cost per employee between gold and iron and "other" is again evident. For total indirect the ratios of gold and iron ore to "other" are .66, .71 and .79 for 1980, 1982 and 1985 respectively. This confirms the change suggested in the previous section. As gold mines increase in size and mature the relative total indirect labour cost per employee tends to converge towards that paid in the larger, old firms in "other". The major component driving this convergence is " Benefit Plans". Gold and iron had per employee costs .36 of "other" in 1980 but by 1985 this had climbed to .46. The strategic factors in the convergence, therefore, are negotiated benefits, i.e., insurance, health, pension, etc. Again this is consistent with a maturing work force.

Distribution of Indirect Labour Costs Required By Law

Table VI-8 shows "payments required by law" for total Ontario metal mining and Canadian manufacturing standardized by gross payroll and Table VI-10 shows the breakdown for gold and iron and "other". The key variable to focus on here is workmen's compensation. This employer cost, especially in mining, comes in for a lot of attention since it is one of the more costly indirect expenses faced by industry. In Table VI-8 we see that since the late seventies workmen's compensation as a percentage of gross payroll has remained constant.[3] What does this imply?

Before we answer this question we should examine the method by which firms are assessed payments under this scheme. Ostry and Zaidi (1979, pp. 214-218) state that:

> "---workmen's compensation represents payments for private insurance. The ratios are, of course, determined by the incidence of accidents for the firm and by the type of work performed. In 1975-76, for example, the average cost per employee was $92 for the petroleum and pipeline industry and $290 for primary metals and metal fabrication. In comparison, the cost for the finance and insurance industry was only $5."

The conclusion from this definition is that costs per employee for workmen's compensation vary between industries. It might be assumed that for mining the premiums paid per employee would exceed those for manufacturing.

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3 Beginning in 1985, under provisions of Bill 101, the Workmen's Compensation Board announced that the average assessment rate would increase 40% by 1987. The maximum rate of income was to be limited to 15% per annum. See Workmen's Compensation, "Proposed 1985 Assessment Rates". (June 15, 1984).

Table VI-8

Percentage Required By Law to Gross Payroll, Ontario Metal Mining and Canadian Manufacturing, 1979-1985

(A) ONTARIO METAL MINING

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	6.4	0.8	0.9	1.1	9.4
1980	6.4	1.1	1.1	0.8	9.4
1981	5.4	1.3	1.0	0.6	8.3
1982	5.2	1.0	1.0	0.6	7.8
1983	4.9	1.7	1.1	0.7	8.3
1984	5.6	1.9	1.0	0.8	9.3
1985	5.7	1.6	1.0	0.8	9.1

(B) CANADIAN MANUFACTURING

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	n.a.	n.a.	n.a.	n.a.	n.a.
1980	1.33	1.27	1.15	n.a.	3.75
1981	n.a.	n.a.	n.a.	n.a.	n.a.
1982	1.2	1.6	1.3	n.a.	4.1
1983	n.a.	n.a.	n.a.	n.a.	n.a.
1984	1.3	2.1	1.2	n.a.	4.6
1985	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Panel A: Ontario Metal Mining: Labour Cost Survey of Ontario Metal Mines - Update.

Panel B: Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada, 1980, 1982 and 1984.

Table VI-8 demonstrates this clearly. For manufacturing the cost of workmen's compensation per dollar of gross payroll is less than 1.5%. On the other hand, for our sample companies in the Ontario metal mining industry the cost per dollar of gross payroll is greater than 5% - more than four and a half times greater. In both sectors, however, this ratio is relatively constant between 1979 and 1985.

Since the quote from Ostry and Zaidi is in terms of cost per employee Table VI-9 was constructed. It compares workmen's compensation costs per employee for Ontario metal mining and Canadian manufacturing. The differences in costs per employee are dramatic. For mining they are currently running at close to $2,000 per employee while in the manufacturing sector they are less than 400 per employee.

There are several conclusions we can draw from this comparison.

(i) One might question whether the risk factor per employee in mining is almost five times that for manufacturing <u>and</u> whether this differential has remained invariant over long periods of time.

(ii) However once these relative premium roles have been established they apparently have been applied consistently since the share of indirect to gross payroll has remained fairly constant.

(iii) It is the growth in gross payroll (wage rates times number employed) that is in fact the driving force for increased <u>total</u> payments by the industry to the workmen's compensation fund.

Table VI-9

Levels - Required By Law Cost per Employee
Ontario Metal Mining and Canadian Manufacturing
1979-85
(dollars)

(A) ONTARIO METAL MINING

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	1,142	154	172	200	1,672
1980	1,463	250	254	163	2,129
1981	1,279	317	237	146	1,973
1982	1,448	279	277	156	2,154
1983	1,486	516	324	200	2,526
1984	1,826	607	338	239	3,010
1985	2,166	645	384	276	3,472

(B) CANADIAN MANUFACTURING

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	n.a.	n.a.	n.a.	n.a.	n.a.
1980	232	222	203	n.a.	657
1981	n.a.	n.a.	n.a.	n.a.	n.a.
1982	255	235	267	n.a.	857
1983	n.a.	n.a.	n.a.	n.a.	n.a.
1984	351	539	308	n.a.	1,198
1985	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Panel A: Ontario Metal Mining: Labour Cost Survey of Ontario Metal Mines - Update.

Panel B: Thorne, Stevenson and Kellog, Employee Benefit Costs in Canada, 1980, 1982 and 1984.

(iv) With the cost per employee in mining near $2,000 it would seem cost effective for the mining industry in cooperation with the government to seek ways of reducing worker risk in order to cut premium payments.

(v) It is apparently the case that each individual group (manufacturing, mining, banking, etc.) is treated independently. If the government wished to lower the cost burden on this key industry (an industry strongly affected by subsidized off-shore competition) it could consider a cross-subsidization scheme, i.e., attempt to smooth out the ratios across industries. This would not seem unreasonable since some of the manufacturing industries enjoy various types of protection which allow them a quasi-rent on their factors, especially capital.

Table VI-10 breaks-out the various benefits for gold plus iron and "other" that are required by law, i.e., workmen's compensation, CPP, unemployment insurance, etc. It also divides the total metal mining industry into our two groups - gold and iron and "other". The estimates shown are benefit costs per dollar of gross payroll. Table VI-11 gives a perspective on actual costs per employee of these plans within this group it is probable that gold costs bias our figures upward whereas iron tends to pull down our estimates. For example under rate provisions set by the WCB (Bill 101), the rates for iron mines are, on average, lower than for gold mines.

The key cost variables here are workmen's compensation and silicosis assessment. Unemployment insurance and Canada Pension Plan payments average about 3% of gross payroll, although the ratio does increase over time. It is worth noting that the cost per employee has risen sharply in recent years. In 1979/80 the cost of these two schemes was

Table VI-10

**Percentage Required By Law to Gross Payroll,
Gold and Iron, and "Other" Metals
1979-1985**

(A) GOLD AND IRON

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	6.44	1.13	1.28	2.33	11.27
1980	6.01	1.18	1.18	1.91	10.28
1981	5.51	1.60	1.23	2.03	10.29
1982	6.25	0.94	1.25	1.92	10.36
1983	5.32	1.72	1.49	1.87	10.41
1984	6.80	2.16	1.17	2.17	12.29
1985	6.97	1.67	1.26	2.38	12.27

(B) "OTHER"

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	5.81	0.65	0.71	0.51	7.68
1980	5.83	0.95	0.97	0.25	8.01
1981	5.31	1.23	0.91	0.17	7.62
1982	4.87	1.01	0.94	0.13	6.93
1983	4.73	1.66	0.93	0.26	7.58
1984	5.18	1.74	0.98	0.25	8.15
1985	5.22	1.63	0.91	0.24	8.00

Source: Panel A and Panel B: Labour Cost Survey of Ontario Metal Mines - Update.

VI-11

Required By Law - Cost Per Employee
Gold and Iron, and "Other" Metals
1979-85
(Dollars)

(A) GOLD AND IRON

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	1,132	199	230	202	1,979
1980	1,245	250	247	393	2,135
1981	1,252	367	282	455	2,334
1982	1,684	261	337	514	2,797
1983	1,463	493	405	510	2,871
1984	2,078	664	359	656	3,758
1985	2,203	564	402	744	3,915

(B) "OTHER"

Year	Workmen's Compensation	Unemployment Insurance	Canada Pension Plan	Silicosis Assessment	Total
1979	1,059	123	133	95	1,409
1980	1,368	220	226	61	1,876
1981	1,288	300	222	43	1,852
1982	1,372	284	257	39	1,945
1983	1,494	524	294	87	2,400
1984	1,734	586	330	88	2,738
1985	2,153	673	378	114	3,318

Source: Panel A and Panel B: Sample Survey of Ontario Metal Mines - Update

about $500 per employee for gold and iron ore producers and between about $350 for "other". By 1985 this had jumped to close to $1,000 per employee for both groups. The main change in these two benefit plans in terms of costs per dollar of gross pay was for unemployment insurance in the "other" group. This took a large jump following the recession of 1982 and has stayed at this higher level since that episode. It reflects the changed experience rating of this group as unemployment rose in the industry after 1982 and remained high to the present.

Workmen's compensation costs per dollar of gross payment, in contrast, have remained fairly stable for both gold and iron and "other" over the period 1979-1985. Silicosis payments as a percentage of gross payroll were also fairly constant over this period. The interesting difference between gold and iron and "other" is the higher silicosis payments of the former group. The rates upon which these payments are made reflect the use of the fund, i.e., number and size of claims by the two groups.

Several preliminary conclusions can be drawn from this break-down: (i) higher costs per employee in the federal unemployment insurance plan are due to the depressed markets for metals that caused extensive lay-offs and (2) the differential silicosis costs are related to the claims on this fund. These special factors aside, the rise in total cost per employee for payments required by law is due, in the main, to the rapid increase in wage levels since, for given ratings, those payments are linked to direct labour costs.

Benefit Plans

Table VI-12 sets out various benefit plans such as private pension plans, life and health insurance and provincial medical plans. In the main, these are benefits provided by the employer to which the employee may or may not contribute. For example, some private pension plans are entirely employer paid and in others both the employer and the employee contribute. The total package of benefits is subject, generally, to negotiation. The figures shown are benefit costs per dollar of gross payroll. Total costs per employee are shown in Table VI-13.

The first point to note is that the cost of benefit plans set out in Table VI-12 per dollar of gross payroll is much higher for our sample of metal mines than is the case for Canadian manufacturing. The reasons for this difference are not clear. From a purely statistical point of view the main reason is the lower contribution rates paid to pension plans in manufacturing than in mining. The total of provincial health plans and private welfare plans is not too much different, i.e., roughly 5-6% of gross payroll. The higher pension contributions in mining may reflect the presence of large corporations in our sample, (i.e., those firms which dominate the "other" group) as compared to Canadian manufacturing. The latter data came from the Stevenson-Kellogg report and it shows a wide array of producers, i.e., from medium to small manufacturers to firms such as De Havilland. This is only a conjecture and it will have to be investigated further. It suggests that workers in mining are prepared to trade off more present dollars (direct pay) for future dollars (pensions). This implies much different discount rates between the two groups with manufacturing workers operating with a higher discount rate. It could also

Table VI-12

Percentage Benefit Plans to Gross Payroll
Ontario Metal Mining and Canadian Manufacturing
1979-85

(A) ONTARIO METAL MINING

Year	Private Pension Plans	Provincial Medical Plans	Life and Health Insurance	Total
1979	3.85	1.87	2.61	9.49
1980	10.16	2.78	2.24	15.63
1981	8.96	2.64	2.15	14.18
1982	7.48	3.71	3.03	14.67
1983	7.98	3.48	2.38	14.26
1984	5.84	2.94	2.62	12.02
1985	6.06	1.85	2.70	11.88

(B) CANADIAN MANUFACTURING

	Pension Plans	Welfare Plans	
1979	n.a.	n.a.	n.a.
1980	4.74	5.72	10.46
1981	n.a.	n.a.	n.a.
1982	4.8	4.9	9.7
1983	n.a.	n.a.	n.a.
1984	4.0	5.4	9.4
1985	n.a.	n.a.	n.a.

Source: Panel A: Sample Survey of Ontario Metal Mines - Update.

Panel B: Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada.

Table VI-13

Benefit Plans - Cost Per Employee
Ontario Metal Mining and Canadian Manufacturing
1979-85
(Dollars)

(A) ONTARIO METAL MINING

Year	Private Pension Plans	Provincial Medical Plans	Life and Health Insurance	Industrial Injury Benefits	Other Benefit Plans	Total
1979	675	336	440	125	83	1,660
1980	2,303	632	513	44	4	3,554
1981	2,201	646	513	12	50	3,473
1982	1,613	769	686	38	91	4,667
1983	2,017	876	656	43	82	3,683
1984	1,794	912	840	36	84	3,751
1985	2,049	659	1,007	22	322	4,147

(B) CANADIAN MANUFACTURING

Year	Pension Plans	Welfare Plans	Total
1979	n.a.	n.a.	n.a.
1980	1,009	1,064	2,073
1981	n.a.	n.a.	n.a.
1982	1,192	1,070	2,262
1983	n.a.	n.a.	n.a.
1984	1,206	1,431	2,638
1985	n.a.	n.a.	n.a.

Source: Panel A: Sample Survey of Ontario Metal Mines - Update.

Panel B: Thorne, Stevenson and Kellogg, Employee Benefit Costs in Canada.

be related to employer turnover. If the latter is higher in manufacturing then, under most defined benefit plans, employer cost is less.

Table VI-13 sets out the cost per employee of these benefit plans. The cost to the mining sector is almost twice as high as it is in manufacturing. Again the main cause of this difference is in pension plan costs.

To see how benefit plans differ between firms within our sample, Tables VI-14 and VI-15 were constructed. The results shown in these two tables are consistent with the hypothesis presented above, i.e., that our sample is dominated by larger firms. As we stated earlier these larger firms tend to have a more extensive benefit package than the smaller producers. They also tend to be more unionized.

The "other" group shows private pension benefit costs two to four times higher than is the case for gold and iron ore. In fact contributions to pension plans account for most of the difference in total indirect costs per dollar of gross payroll.

The higher benefit plan ratios to gross payroll are reflected in costs per employee (Table VI-15). In fact by 1984 the "other" group is paying out almost five times more per employee than is the case for gold and iron ore. The other interesting point is that for the "other" group costs per employer have fallen since 1980. The drop occurred in 1982 - a year of depressed markets. It may have been the case that the firms so hit by poor markets developed widespread earlier retirement schemes. This plus lay-offs apparently lowered their pension costs per employee.

Table VI-14

Percentage Benefit Plans to Gross Payroll
Gold ands Iron, and "Other"
1979-85

(A) GOLD AND IRON

Year	Private Pension Plans (2)	Provincial Medical Plans (2)	Life and Health Insurance (3)	Total[1] (4)
1979	1.96	2.18	1.59	6.24
1980	3.25	1.19	6.67	6.42
1981	2.49	1.20	2.10	6.06
1982	2.76	1.25	1.86	6.25
1983	1.72	1.27	2.26	5.91
1984	2.02	1.19	3.07	7.21
1985	1.16	1.23	2.67	6.27

(B) "OTHER"

Year	Private Pension Plans (2)	Provincial Medical Plans (2)	Life and Health Insurance (3)	Total[1] (4)
1979	4.54	1.76	2.99	10.69
1980	10.93	2.95	2.30	16.67
1981	9.69	2.81	2.15	15.10
1982	8.02	3.99	3.16	15.25
1983	8.73	3.74	2.40	15.27
1984	6.32	3.16	2.57	12.63
1985	6.65	1.92	2.70	12.56

Source: Sample Survey of Ontario Metal Mines - Update.

Note: (1) Some amounts were also paid for Independent Injury Benefits and for Other Benefit Plans. These are not included here and thus the Total (Col. 4) is greater than the sum of Cols. (1), (2) and (3).

Table VI-15

Benefit Plans - Cost Per Employee
Gold and Iron and "Other"
Ontario Metal Mining
1979-1985
(Dollars)

(A) GOLD AND IRON

Year	Private Pension Plans	Provincial Medical Plans	Life and Health Insurance	Industrial Injury Benefits	Other Benefit Plans	Total[1]
1979	380	382	307	82	1	1,154
1980	690	264	365	65	1	1,386
1981	565	283	488	58	4	1,398
1982	773	347	530	98	3	1,749
1983	537	342	650	98	5	1,704
1984	630	369	946	273	2	2,239
1985	417	370	867	135	3	2,026

(B) OTHERS

Year	Private Pension Plans	Provincial Medical Plans	Life and Health Insurance	Industrial Injury Benefits	Other Benefit Plans	Total[1]
1979	784	319	489	140	114	1,847
1980	2,484	674	530	42	5	3,798
1981	2,386	687	516	6	55	3,709
1982	1,710	817	704	31	101	3,361
1983	2,197	941	657	36	92	3,923
1984	1,941	980	824	6	94	3,942
1985	2,247	693	1,024	8	361	4,404

Source: Sample Survey of Ontario Metal Mines - Update.

Note: (1) See Table VI-13.

Adjusted Measures of Factor Cost Shares

In the original study we set out to ascertain the extent of under reporting in the wage bill of Ontario metal mining due to the omission of indirect labour costs. We found that it was not a unsubstantial amount, ranging from 1.30 to 1.45 greater than when indirect wage costs are omitted. This, then, represents the difference between the price of labour and the cost of labour.

This ratio, slightly modified is shown in Table VI-16. The estimates for the period from 1979 to 1985 closely approximate those we found for the period 1961 to 1979. The average increase over "pay for time worked", (i.e., direct wages), for indirect labour costs is close to 355. Since 1979, as we have previously discovered, this difference has remained relatively unchanged.

The interest is in the difference between the composite gold and iron ore sector vs. "other". Between 1980 and 1985 the ratio of indirect to direct wages for "other" has remained relatively constant. This is not the case for gold and iron ore. The ratio here has increased from 128.06 to 134.68. This reflects the increased maturity of these industries and the impact of this on indirect labour costs.

Although of interest in its own right, this ratio was constructed to allow us to adjust the factor shares used in the estimate of total factor productivity. We found in the original study (Table IV-1) that labour's factor share (i.e., its share of total cost of production) increased from 21.2% to 25.4% between 1961 and 1971 and from 20.9% to 19.3% for the period 1975-77.

Table VI-16

Direct and Indirect Labour Costs Per Employee
Gold and Iron, "Other", and Total Metals
1979-85

Year	Direct Wages[1] (Pay For Time Worked) (1)	Indirect Labour Costs (2)	Direct Wages Plus Indirect Labour Costs (3)	Ratio Col. (3)/(1) x 100 (4)
		(A) TOTAL METALS		
1979	16,223	5,162	21,385	131.82
1980	20,046	7,976	28,022	139.79
1981	21,317	8,325	29,642	139.05
1982	19,721	9,797	29,518	149.68
1983	23,513	9,365	32,878	139.83
1984	27,965	10,455	38,420	137.39
1985	29,800	12,006	41,806	140.29
		(B) GOLD AND IRON		
1979	16,322	4,622	20,945	128.32
1980	19,357	5,431	24,788	128.06
1981	20,702	5,813	26,515	128.08
1982	24,536	7,216	31,752	129.41
1983	24,978	7,220	32,918	128.91
1984	27,692	8,933	36,625	132.26
1985	27,969	9,699	37,668	134.68
		(C) OTHER		
1979	16,187	5,363	21,550	133.13
1980	20,124	8,262	28,386	141.06
1981	21,388	8,610	29,998	140.26
1982	19,168	10,094	29,262	152.66
1983	23,336	9,625	32,961	141.25
1984	27,999	10,647	38,646	138.03
1985	30,022	12,287	42,309	140.93

Source: Sample Survey of Ontario Metal Mines - Update.

Note: (1) Direct Wages (i.e., Pay For Time Worked) is not equivalent to Gross Payroll. See Text.

The adjusted labour cost shares were constructed by multiplying the cost shares for labour shown in Table IV-1 by the ratio of indirect to direct labour payments (Table VI-14). The resulting product is the " adjusted labour cost share" and it appears in Table VI-17. We estimated capital's share as a residual, i.e., we added labour, materials and energy shares and subtracted this sum from one. The assumption in such an exercise is that the industry is subject to constant returns to scale.

The results of this exercise (Table VI-17) are quite interesting. Labour's share in total cost jumps by close to 44% for the period 1978-81 and by about 30% for the period 1982-84. Since we are assuming constant returns to scale and are estimating capital's share as the residual, this implies, given that the shares of material and energy are fixed, that capital's share must decline. We see this in Table VI-17 where capital's share falls by 31% over the period 1978-81 and 24% over the period 1982-85.

What does this imply about our estimates of total factor productivity (Chapter IV, Table IV-4)? We started this exercise to see the direction of bias in the TFP (total factor productivity) estimates due to an under reporting in labour's share of total cost. In Chapter IV (Table IV-2) we observed that between 1981 and 1984 output per worker grew at an annual rate of 4.8% per year while output per unit of capital declined at an annual rate of 7.1%. Recall that we estimate total factor productivity as the difference between the growth of real output and the change in the weighted (where the weights are the factor shares) sum of the partial factor productivities.

The biases work as follows. Since labour productivity is increasing, its effect on the weighted sum will be larger than before its factor share was adjusted for omitted indirect

Table VI-17

Unadjusted and Adjusted Mean Cost Shares Of $K^{(1)}$, L, M and E.
Ontario, Total Metal Mines, 1978-84

	S_K		Percentage Change	S_L		Percentage Change	S_M	S_E
	Adjusted (1)	Unadj. (2)	Col.(2)/Col.(1)[2] (3)	Adjusted (4)	Unadj. (5)	Col.(5)/Col.(4) (6)		
1978-81	0.3361	0.2327	-30.76	0.2334	0.3368	+44.30	0.3902	0.0403
1982-84	0.4171	0.3191	-23.49	0.2317	0.3297	+29.72	0.3060	0.0452

Source: See Table IV-1.

Note: (1) Capital's share here is estimated using the residual method.
(2) Col. (2) minus Col. 1 divided by Col. (1)

labour costs. It is worth repeating that the labour cost share was derived from published data on wages and salaries paid to mine workers. This is the procedure followed by virtually everyone who makes these types of calculations. We have the benefit of additional information on indirect labour costs. The change in weights, therefore, will lower the growth of total factor productivity over its trend using an unadjusted labour share. This occurs since labour productivity is growing relative to capital productivity. As a result of these adjustments to labour's factor share technological change as a component of efficiency is reduced.

The other bias this creates is in the rate of capital/labour substitution. As we found in the original study (Chapter 1) factor substitution, (e.g., the substitution of capital for labour) depends both on the relative price of the factor, i.e., the price of labour relative to the price of capital, and on the size of the factor's share in total cost. If the latter is large and its relative price rises, then, there is a strong incentive to substitute the less expensive for the more expensive factor of production. In our case, substitute capital for labour. With an upward adjustment to labour's factor share due to the inclusion of indirect labour costs there is an added (unmeasured) incentive to bias technological change towards more capital utilization.

The interesting difference between the period after 1979 and before 1979 is that before 1979 the indirect labour cost share was <u>rising</u> over time. Since 1979 the share has been constant. Hence, although we underestimated the true cost of labour by omitting indirect labour cost, since 1980 it is more the <u>price</u> of labour that has influenced the relative price of capital and labour. Before 1979 there was a joint effect of a rising price

of labour (direct wages) and a relative increase in indirect labour costs. It is this latter relative rise which is absent after 1980.

Rates of Return to Capital

Since we have labour factor shares which include indirect labour costs, it is possible to estimate new capital shares. Recall that the latter are derived as a residual after summing the shares of all other factor inputs. How does this change affect the crude rate of return to capital in metal mining? Table VI-18 and Graph VI-1 show the unadjusted (original labour share) and adjusted (labour share adjusted for indirect labour cost) ratios of return to capital.

In the original study we found that this adjustment had little effect on the rate of return but, of course, as indirect to direct costs increased during the seventies the gap between adjusted and unadjusted labour shares widened. Our updated estimates suggest the following. First, the rate of return to capital,[4] after rising in the early eighties, has trended downward in recent years. These short run changes are evident using both the adjusted and the unadjusted factor shares. Secondly the gap between the series has narrowed. This is opposite to the earlier finding, i.e., comparing to the sixties and seventies, and again reinforces the finding of the constancy of indirect to direct labour costs in the eighties after the steep rise in their ratio between the late sixties and late seventies.

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4 We are less interested in levels since this estimate of rate of return, i.e., residual method, means that capital's share is not only before taxes but includes returns to land, working capital and inventories as well - a gross return.

Table VI-18

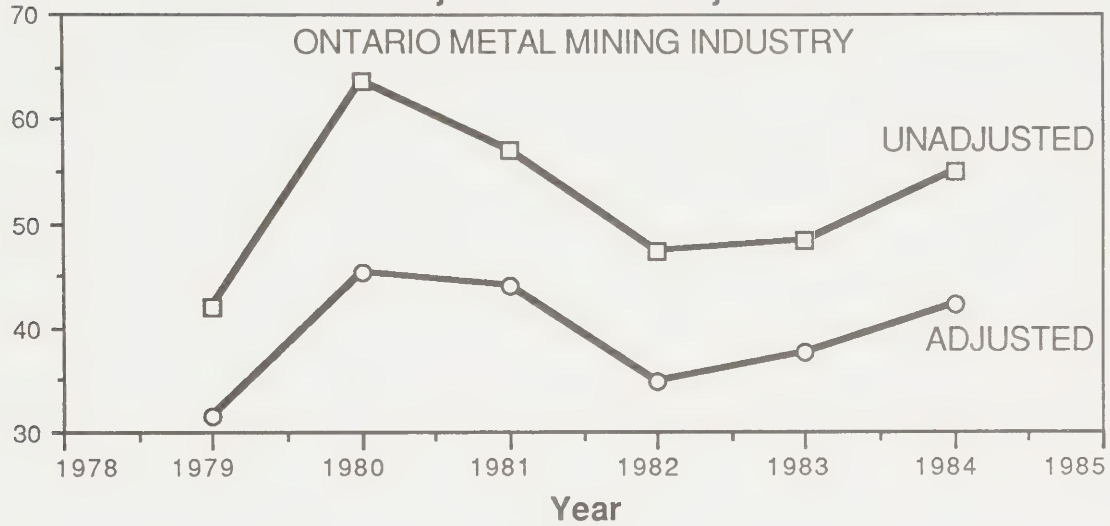
A Comparison of the Rate of Before Tax Return to Capital[1] in The Ontario Metal Mining Industry, Adjusted vs. Unadjusted Capital Share, Annually, 1979-84

	Rate of Return to Capital	
Year	Unadjusted (1)	Adjusted (2)
1979	41.9	31.6
1980	63.7	45.4
1981	57.0	43.9
1982	47.4	34.9
1983	48.4	37.6
1984	54.9	42.3

Source: Col. (1) - See Table V-2.

Note: (1) This ratio includes rent as well as the return to fixed capital. It is not a simple accounting profit.

Graph VI-1
Rate of Return to Capital
Unadjusted and Adjusted



Finally we observed a drop in the rate of return to capital between the sixties and the seventies. If we take the period from 1980 to 1984 the rate of return is down but only slightly. This reduced return it might be hypothesized, is due to the large build up in capital stock discussed in Chapter IV. It would be interesting to pursue (a) why such large amounts of capital were invested over the last few years and (b) examine the short term rate of return to this investment. The explosion of investment activity since the early eighties is clearly <u>the</u> dynamic factor in the Ontario metal industry so far in this decade. Is the industry simply getting ready early for the next resource boom anticipated by management.

Chapter VII

MINING BENEFIT COSTS: CANADA VS. UNITED STATES

Another way to observe how the costs of mining operations have changed in the eighties is to compare the Ontario experience with the benefit costs paid in metal mines in the United States. Very little effort has been made to make such a comparison, at least in a systematic manner. What follows, then, is a first attempt to compare direct labour costs per hour and indirect labour costs as a percentage of gross payroll and between Ontario and the United States.

Although the data are scarce we will compare the following: (1) hourly wages, (2) rates of change in hourly wages during the eighties, (3) benefit packages provided in the U.S. and Canada and (4) the ratio of benefits paid to gross payroll. Every effort has been made to ensure comparability between mining groups. For example data are segregated by surface vs. underground operations. This division is used when making cross country comparisons.

U.S. Data Source

The principal source for the U.S. mining data comes from a publication entitled, "Mining Cost Service - Update, 1986", published by Western Mining Engineering. This publication services mining operations in the United States and reports its findings on a state basis. The "Survey" provides a summary of its findings at the beginning of the report. This summary is followed by detailed information on mining costs such as type of

benefit plans, life insurance, medical insurance, etc.; number of paid holidays and number of weeks of vacation, by years of service. Finally a detailed review is made, at the mine level, of "benchmark hourly wages". The latter covers a wide range of mine occupations from labourers to electricians. This information is also broken down between union and non-union mines. It is possible, therefore, to obtain figures for our main groups, i.e., gold, iron ore and "other".

Growth in Mining Wages

Table VII-1 compares the growth in mining wages in Canada and the United States between 1980 and 1986. Column 3 shows the annual percentage change in metal prices for Canada over this same period. The difference between nominal wage changes (cols. (1) and (2)) and the change in metal prices is a crude measure of the growth in product wages. They state that real wages, for productivity analysis are derived by dividing nominal wages (W_N) by the price of the product produced by this labour (P_M)

$$\text{i.e.} \qquad W_R = \frac{W_N}{P_M} \qquad (1)$$

where

W_R = real (product) wage
W_N = nominal wages
P_M = metal prices

Before we begin to analyze the data in Table VII-1, a caveat is necessary. "Mining wages" for the U.S. covers all mining operations including coal mining activity. The latter

Table VII-1

Average Annual Increases in Mine Wages
For Canada and The United States, 1980-1986
(Percentages)

	Canada[1] (1)	United States (2)	Metal Prices[2] (3)
1980	11.80	8.0	4.6
1981	13.2	9.6	-20.2
1982	13.8	7.3	-18.8
1983	5.7	4.8	- 0.5
1984	2.5	2.9	- 5.0
1985	4.0	3.0	- 9.7
1986	1.3	3.8	- 3.9
Av. (1980-86)	7.5	5.6	-----

Note: (a) Includes overtime.

Source: Col. 1. Statistics Canada, Employment Earnings and Hours Worked (#72-002), and Canadian Statistical Review

Col. 2. Ontario Metal Mining Labour Cost Survey, Update.

Note: (1) Includes overtime.

(2) By subtracting the change in metal prices from the change in nominal wages (Cols. (1) and (2)), an estimate of real product wage change can be obtained.

forms a significant share of U.S. mining output while in Canada, coal's share is much smaller. In addition the two series may not measure exactly the same wage component of mining costs. For example in the Canadian case overtime is included. It is not clear whether this component is included in the U.S. figure. However, these points aside, since our main interest here is with changes in mine wages rather than with levels one can be fairly confident that the basic trends shown reflect underlying wage movements in the two countries.

The trend is quite revealing. Over the whole period (1980-1986) the average annual wage increase in Canada was 7.5 percent while in the U.S. it was 5.6 percent. We do not know the levels of mine wages in 1980 but even if we assume, exchange rate adjustments aside, that they were approximately equal, these overall averages indicate that labour costs by 1986 were above those in the U.S. (see the next section for a comparison in 1986).

The path by which each country reached this average is quite different. In Canada's case mining wages increased at double digit levels until 1982 (i.e., this latter estimate as for the others is computed as the percentage increase 1982 over 1981). After 1982 the rate of change in annual wages dropped sharply so that by 1985/86 the increase was only 1.3%. The U.S. pattern was similar in terms of the timing of trend breaks, i.e., higher before 1982 than after this date, although here the similarity ends. In the early eighties wage increases in the U.S. were about 25% less than wage increases in Canada. After 1982 U.S. mining wage increases fell to approximately half their earlier level. Hence from 1984 to 1986 Canadian wage increases were less than their American counterpart. From 1983

to 1986, then, the annual average increase in wages was 3.4 percent while in the U.S. it was 3.6 percent.

The different reaction to the deep recession of 1981/82 in metal prices between Canada and the U.S. is quite interesting. Canada pulled back very sharply on wage increase, i.e., dropping the increase to labour a third of its former level. The U.S. decline, albeit from a lower peak, was more modest. It is necessary here to add a word of caution. If a mine closes, as happened quite a bit in the U.S., this serves to bias average wage increases upwards, i.e., the closed mines are removed from the sample. In Canada, one suspects that fewer mine closures occurred. Hence the downward pressure on the average increase was less than in the U.S.

Another factor is wage reduction. In the U.S. a number of copper companies and some, but not many, coal companies negotiated wage reductions with their employees. This policy was adopted to make wage changes more consistent with lower metal prices. This would tend to lower average wage increase since the mines affected stayed open. Wage reduction schemes were not implemented in Canada. Apparently Canadian mine workers chose (a) to potentially absorb more layoffs, i.e., higher unemployment and (b) to affect the wage adjustment by a generally lower percentage increase than in the U.S. We cannot statistically evaluate the social or private cost of these two wage setting patterns but they point to very different behavioural patterns as a result of a fall in output prices.

Finally, the trends in product wages, i.e., nominal wage increases less change in metal prices (see Table VII-1), are strongly upward in both countries. Canada, however,

for the early eighties shows much higher rates of real wage growth than does the U.S. Both countries, though, witnessed a growth in real wages. There is nothing wrong with such increases if they are matched by equal increases in total factor productivity. We know (Chapter IV) that this matching did not occur in Canada and one suspects that parity was not achieved in the U.S. mining industry over this period. We would expect, then, a fall in mining profits and a strong move in both countries for capital labour substitution to take place. Again we saw a sharp rise in capital-labour ratios in Canada.

Level of Mining Wages in Canada and the U.S.

In the previous section it was suggested, but not proved that, given the higher annual increase in nominal wages in Canadian mining versus U.S. mining, by 1986 the former, in level terms, would exceed the latter. Table VII-2 was constructed to test this hypothesis.

The comparison of differences in wage levels is even more subject to concern than was the case for comparative wage increases. As one can see from Table VII-2 the U.S. figures are mine/region specific whereas the Canadian figures cover the whole country. In addition we do not know precisely which mining occupations are included in the Canadian average whereas we do know for the U.S. However, in the U.S. we do not know the numbers of mine workers included in each category and so we cannot obtain a proper weighted average.

With these concerns recognized, it is still the case that Canadian average wages are much higher than hourly wage for even the most skilled mining workers (electricians) in

Table VII-2

Level of Mining Wages in Canada and The U.S., 1986

(a) United States

Benchmark Hourly Wages[1]

Underground laborer	9.04
Underground equipment operator	10.02
Miner	10.24
Electrician	10.94
Mill equipment Operator	10.28
Mechanic	10.61

(b)Canada[2]

Average Hourly Wage	15.87

Sources: See Table VII-1.

Notes: (1) Covers hourly wages paid in underground metal and industrial mineral mines in the eastern U.S.

(2) Covers all metal mines.

the U.S. Apparently the difference is close to 50%, i.e., Canada over the U.S. Our hypothesis cannot be rejected. The large annual wage increases in Canadian mining in the earlier eighties have an average before tax wage paid higher than the most skilled hourly wage rate in the U.S.

The comparisons shown in Table VII-2 are in local currency terms. In 1982 the Canadian dollar was selling for $1.389 against the U.S. dollar (average noon rate). If we were to convert the Canadian hourly rate into U.S. dollars it would lower the former to $11.43 per hour. The lower Canadian dollar, therefore, goes a long way towards closing the wage gap between the two countries. Part of the gap may be closed as well by the lower U.S. income tax payable. We cannot say whether such an exchange rate adjustment brings competitive equality, since we must know how productive labour is in Canada relative to its U.S. counterpart before a full evaluation is possible.

Benefit Plans in the U.S.

Before a comparison is made of Canada-U.S. indirect to direct labour costs it might prove helpful to briefly review the type of benefit plans available to U.S. mine workers. Here the actual plans adopted by the mines differ quite substantially depending on whether the mine is unionized or not. Generally the unionized mines have more benefits available to their employees than do non-unionized mines.

(a) Required by Law

(1) Unemployment Insurance

As in Canada the U.S. has established funds at the federal and state level to be used by workers when they become unemployed. In the case of the Federal Unemployment Tax, the employer bears the full cost. Unemployment insurance taxes are also imposed by the individual states (these are allowed as a deduction against federal taxes paid). Normally the employer pays the state unemployment tax. The tax rate is set on the basis of an industry experience rating and the current state of the fund.

(2) Social Security Tax

Unlike Canada, the U.S. imposes a tax on employee earnings to provide funding for retirement, disability and other benefits. This is a federal tax where the employers and employees each contribute 7.15% of wages up to a maximum wage of $43,800.

(3) Workers Compensation Insurance

All states require employers to carry insurance to pay medical and other expenses for employees injured on the job. Recently employers have been allowed to contract with private carriers to secure this insurance. One presumes this competition, versus the state monopoly practices formerly employed, has lowered rates. As we noted in the previous chapter compensation costs per employee in mining are close to $2,000 a year.

A crude comparison of total compensation costs per employee in the U.S. can be made by multiplying an average state rate of $12.50 per $100 dollars of payroll. If we take the Canadian average gross payroll per employee in 1984 ($36,000), this gives a cost to the mine owner in the U.S. of $4,500 approximately - almost twice the rate paid in Canada! In fact in North Dakota the state imposes a maximum of $3,600. In the high silica mines in New York state the rate per $100 of payroll is $41.05. At a first, and admittedly crude level of comparison, Canadian mining employer costs would seem to be substantially lower than the amount paid per employee by U.S. mine operators.

Relative Cost of Benefits

In Chapter 6, an exhaustive study was carried out on the cost of various benefit plans standardized by gross payroll and by employees. How do the Canadian ratios, then, compare with U.S. mining. Unfortunately we only have the U.S. figures in terms of cost per dollar of payroll. Also we only have one observation - for 1986. The last observation for Canada is 1985. However since these ratios change only slowly the one year difference should not distort our conclusions.

Table VII-3 shows the indirect labour costs per dollar of gross payroll for a sample of Ontario and eastern U.S. metal mines. The mining groups shown are close. In the case of gold, the Canadian figures include iron ore production. However, this grouping is dominated by gold producers. The other category is more extensive in Canada than in the U.S., although both include copper, lead, silver and zinc producers. Finally the U.S. figures are for unionized mines. We felt that since the majority of mines covered in the Ontario sample were unionized this was the better comparison. This is an important

Table VII-3

A Comparison of Indirect or Benefit Costs To Gross Payroll in Ontario and the United States For 1986

	Gold (1)	Other[1] (2)	Total (3)
U.S.	26.5	33.6	37.0[3]
Ontario[2]	30.5	34.3	33.9

Source: U.S. Mining Cost Survey, 1986.

Ontario: See Tables VI-4 and VI-5.

Notes: (1) Includes copper, lead, zinc mines.

(2) For 1985.

(3) Underground metal and industrial mineral mines, eastern U.S.

point since, as mentioned above, unionized mines in the U.S. tended to have more benefit plans than did non-union mines.

The ratios of indirect to direct labour costs shown in Table VII-3 are remarkably similar in both countries. Apparently about thirty percent of gross payroll goes to providing various negotiated and required by law benefit plans. The ratios are also quite similar when we partition the total into gold and "other". In the U.S. the ratio for gold is four percentage points lower. This may be due to the presence in the U.S. of a larger number of small gold operators. Recall that the Ontario ratio has only climbed to the 30% level in the last few years.

The evidence, then suggests that since U.S. hourly wage payments are less than their Canadian counterpart, overall U.S. mine operators are incurring lower benefit costs per employee than is the case in Canada. As we saw above workmen's compensation costs are higher in the U.S. The U.S. averages include, besides workmen's compensation, unemployment insurance, social security and private plans like health and life insurance, holidays, vacations, etc. Although we cannot demonstrate it with these data one hypothesis is that U.S. mine operators provide less privately negotiated benefits than do their Canadian counterparts.

What conclusions can we draw from this comparative exercise? First, average hourly mining wages in the U.S. are substantially lower than they are in Canada. Second, this gap is partly explained by the much higher annual wage increases received by Canadian mine employees in the early eighties than was the case in the U.S. Third, although the ratio of benefit costs to gross payroll is about the same in Canada and the U.S., the

lower average direct wage paid in the U.S. suggests, but does not prove, that indirect labour costs per employee are lower than in Canada.

Chapter VIII

SUMMARY

This study has examined the development of the Ontario metal mining industry during the period 1975 to 1985. It builds on an earlier work (see Mineral Policy Background Paper No. 19), that studied this industry from 1961 to 1977. The principal objective of both studies was to investigate the relationship between prices, productivity and wages. As such the studies examined trends in output per work and multifactor productivity (total factor productivity), and explored the relationship between the price of labour (direct wages) and the cost of labour (indirect compensation plus direct wages). If one question dominates this study, then, it might be; How did the Ontario metal mining industry adjust to the changed international competitive environment of the last decade?

In the original study (Policy Paper No. 19), the industry had just entered the long recession. The latter began with the sudden increase in energy costs in 1974. Producers, even by 1977, were uncertain as to whether the changed international environment was temporary (3 or 4 years), or signalled a very different world from the one they had worked in since the end of the Second World War. The answer is now clear, but it wasn't at the time.

Our investigation of the industry over the last decade suggests the following:

(i) Productivity growth in the Ontario metal mining industry continues to be slower than for the economy as a whole.

(ii) This slower growth in efficiency is not due to under-investment. In fact the annual growth of capital stock in the Ontario metal mining since 1980 is about equal to that in the country as a whole. Thus the industry is absorbing, through this investment, the latest technology.

(iii) The principal reason for the slower growth in multifactor productivity is the slow growth in markets for the industrys' products. A combination of declining real output and expanding capital stock has forced down the growth in total factor productivity.

(iv) The growth of white collar workers, which we have defined as a quasi-fixed factor of production, was reversed in the eighties. This is an important finding since it calls into question the assumed complementarity between fixed capital (machines and buildings) and quasi-fixed capital (non-production workers). It also has important implications for the growth in efficiency since in the sixties and seventies white collar employment grew faster than real output so lowering overall efficiency growth.

(v) The industry continued to down size its blue collar work force. Adjusting the latter to new production levels has been accomplished, as one might expect, with a lag. However, it is now more in line with current levels of real output.

(vi) Production workers and capital are usually seen as substitutes. In fact it has been argued that technological change in recent times has been biased towards labour saving innovations. This is certainly the case for Ontario metal mining. During the eighties the capital labour ratio has increased sharply.

(vii) On the cost side, capital costs have escalated during the eighties. This is the joint result of rising interest costs, plus steeply rising prices for capital goods. These added costs have apparently not deterred producers as the industry is currently undergoing an investment boom. One suspects, but cannot prove, that this investment boom is in

anticipation of the resource boom expected in the nineties. However, as mentioned in point number (iii) above, this large scale investment has serious short-run implications for efficiency growth given the current level of demand for metals.

(viii) An important discovery in the original study was the growing gap between the price of labour and the cost of labour, i.e., the rise in indirect labour costs to direct wages. This relative rise has apparently stopped. For the eighties, then, the share of indirect labour costs per dollar of gross payroll has remained relatively constant.

(ix) The cost of indirect payments per employee, however, has continued to rise. Thus one must conclude that the main factor forcing up total indirect labour costs is the growth in wages.

(x) A comparison of U.S. and Canadian direct and indirect labour costs reveals; (a) that in the early eighties Canadian average wages increased much faster than their American counterpart. However, in recent years the Canadian increase has been lower than that observed in the U.S.; (b) the share of indirect labour costs per dollar of gross payroll is slightly higher in Canada. The composition of indirect payments is different. In Canada, pension costs force up indirect payments while in the U.S. workmen's compensation costs are much higher. Other benefit costs, per dollar of gross payroll, are very similar.

The overall conclusion is that the Ontario metal mining industry has made good progress towards adapting to new international competitive conditions. Current high levels of investment imply the absorption of new techniques. The "pay-off" in improved efficiency will probably have to await a return to stronger markets, and higher commodity prices.

The two recommendations suggested in the original report are in the process of implementation, i.e., bring the share of indirect labour costs under control and continue to adopt new technology, i.e., raise capital labour ratios.

Future Research

(i) Again it is important that a "watching-brief" be kept on trends in cost and efficiency as a guide to the industry on its success in adapting to international competitive conditions.

(ii) The adoption of new technology should be studied carefully. Have the recently high investment levels brought the best practice technology. We need to know more about energy costs, technological change and productivity. This type of study will need new and more accurate measures of capital.

(iii) The research here has used a blend of establishment data drawn from our sample of Ontario metal mining producers and industry level data collected by Energy, Mines and Resources and Statistics Canada. The next logical step is to extend our work on productivity to the establishment level, as we have done for work on direct and indirect labour costs. Moving to a more micro approach will allow a better investigation of how export industries adapt to changing international markets.

Appendix Table 1

Cost Shares of K, L, B, W, E and M Inputs in Ontario Metal Mining
1975-1984

Year	S_K (1)	S_L (2)	S_W (3)	S_B (4)	S_M (5)	S_E (6)
1975	0.4266	0.1984	0.5750	0.1408	0.3443	0.0306
1976	0.4053	0.2063	0.0583	0.1480	0.3523	0.0361
1977	0.3634	0.2238	0.0636	0.1602	0.3696	0.0433
1978	0.2926	0.2390	0.0763	0.1627	0.4189	0.0496
1979	0.3125	0.2411	0.0773	0.1639	0.4004	0.0460
1980	0.3281	0.2366	0.0679	0.1661	0.3968	0.0385
1981	0.3676	0.2226	0.0711	0.1515	0.3735	0.0363
1982	0.4382	0.2324	0.0619	0.1534	0.2883	0.0411
1983	0.4090	0.2304	0.0718	0.1587	0.3137	0.0468
1984	0.4041	0.2324	0.0655	0.1669	0.3160	0.0476

Notation: K = total capital including return toland
L = total labour
W = non-production workers
B = production workers
M = materials and supplies
E = energy

Source: Ontario Metal Mining Statistics, Mineral Policy Background Paper No. 16, Ministry of Natural Resources.

Metal Mines, Statistics Canada, Cat. #26-223.

Appendix Table 2

Quantities of Output and Inputs,
Ontario Metal Mining Sector

1975-1984

Year	Y	K[1]	L	W	B	M[2]	E
	thousands of short tons	millions of $	man years	man years	man years	millions of constant $ (1971=100)	millions of B.T.U.'s
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1975	57,908.80	1,843.98	28,671	6,578	22,093	397.67	33,500,040
1976	61,360.17	1,865.42	29,054	6,479	22,575	426.52	37,119,580
1977	59,852.22	1,894.87	29,178	6,626	22,552	453.35	33,792,360
1978	54,748.78	1,872.78	23,297	6,180	17,117	391.44	30,499,000
1979	46,459.77	1,897.31	23,085	6,306	16.779	361.43	22,713,000
1980	46,703.09	1,998.00	27,454	6,876	20,578	415.39	23,536,000
1981	45,919.99	2,087.32	27,967	7,517	20,450	432.16	23,188,000
1982	33,173.75	2,141.97	25,869	6,852	19.013	291.28	20,491,000
1983	36,244.57	2,253.56	22,967	5,929	17,038	305.99	21,661,000
1984	44,861.42	2,482.70	23,304	5,762	17,542	339.88	23,634,000

Notation: K = real capital stock
L = total labour
W = non-production workers
B = production workers
M = materials and supplies
E = energy

Notes: (1) Col. (2): The method of estimating the real capital stock can be obtained from the authors at the Department of Economics, Queen's University.
(2) Values for Materials and Supplies for 1975-1977 differ from those of original Volume due to change of Base Year to 1971=100.

Source: Ontario Metal Mining Statistics, Background Paper, No. 16, Ministry of Natural Resources, and Metal Mines, Statistics Canada, Catal. #26-223.

Appendix Table 3

**Production and
Non-Production Workers in Gold, Iron and "Other"
Metal Mining Industry, 1975-1984**

Year	Gold		Iron Ore		"Other"	
	B	W	B	W	B	W
1978	2,458	460	X	X	14,659	5,720(1)
1979	2,410	481	X	X	14,369	5,825(2)
1980	2,604	569	1,861	400	16,113	5,907
1981	2,849	614	1,747	420	15,854	6,483
1982	2,667	625	1,344	372	15,002	5,859
1983	2,906	694	1,132	381	13,000	4,854
1984	3,276	629	1,283	347	12,984	5,133

Notation: B = production workers
W = non-production workers

Notes: (1) - includes iron ore since not reported separately
(2) - confidential to meet secrecy requirements of the Statistics Act

Source: Metal Mines: Statistics Canada, Cat. #26-223.

Appendix Table 4

Compensation Paid Per Employee for Total, Gold and Iron Ore and "Other" Mining Activities in Ontario, 1975-1984

Year	Total Mining $ (1)	Gold and Iron Ore $ (2)	"Other" $ (3)
1975	12,488	12,012	12,671
1976	14,027	14,290	13,936
1977	15,191	15,958	14,942
1978	18,251	------	18,652
1979	20,547	------	20,972
1980	22,307	22,354	22,295
1981	25,092	24,318	25,787
1982	26,218	28,276	25,724
1983	29,242	29,615	29,036
1984	33,341	33,186	33,389

Source: Metal Mines - Statistics Canada Cat. #26-223

Appendix Table 5

Distribution of Compensation Payments Per Employee
Total Metals, Annually, 1975-1985

	Direct		Indirect			
Year	Pay For Time Worked (1)	Paid Time Off (2)	Other (3)	Payments Required By Law (4)	Plans (5)	Benefit Total Indirect (6)
			(DOLLARS)			
			A			
1975	11,608	1,622	123	920	1,626	4,291
1976	13,724	1,748	152	1,325	2,270	5,495
1977	15,050	1,827	217	1,700	2,513	6,257
1978	13,940	1,603	235	1,421	2,356	5,615
1979	14,160	1,900	361	1,394	2,684	6,339
			B			
1979	16,224	1,430	188	1,885	1,660	5,163
1980	20,047	2,510	217	1,695	3,554	7,976
1981	21,318	2,712	247	1,893	3,473	8,325
1982	19,721	2,923	306	1,901	4,667	9,797
1983	23,513	2,969	462	2,252	3,683	9,365
1984	27,965	3,282	386	3,035	3,751	10,455
1985	29,800	37,58	600	3,501	4,147	12,007

Source: Panel A: See Appendix Table 5, Productivity and Labour Costs in the Ontario Metal Mining Industry, Mineral Policy, Paper #19, Ontario Ministry of Natural Resources, 1985.
Panel B: Sample Survey of 15 Ontario Metal Mines, conducted by the authors.

Note: (1) The figures for 1979 differ in Panel A and Panel B due to changed definitions for the various categories reported by the firms surveyed. However the authors are confident that the trends shown in the original study and in the update are representative of changing actual conditions.
(2) "Other" refers to such items as "non-production bonuses", Profit-Sharing Plans, etc.

Appendix Table 6

Distribution of Compensation Payments Per Employee
Gold and Iron Ore, Annually, 1975-1985

Year	Direct: Pay For Time Worked (1)	Indirect: Paid Time Off (2)	Other (3)	Payments Required By Law (4)	Benefit Plans (5)	Total Indirect (6)
	(DOLLARS)					
	A					
1975	11,484	678	376	1,330	597	2,981
1976	13,529	923	473	1,645	796	3,837
1977	15,411	1,060	579	1,877	1,016	4,532
1978	19,378	1,063	403	1,694	969	4,129
1979	18,244	1,336	1,143	2,021	1,280	5,780
	B					
1979	16,322	1,317	316	1,835	1,154	4,622
1980	19,357	1,539	463	2,044	1,386	5,432
1981	20,703	1,638	463	2,316	1,398	5,813
1982	24,536	2,206	514	2,747	1,749	7,216
1983	24,978	2,178	518	2,820	1,704	7,220
1984	27,692	2,397	538	3,759	2,239	8,933
1985	27,969	2,788	1,045	3,839	2,026	9,699

Source: See Appendix Table 5.

Notes - See Appendix Table 5.

Appendix Table 7

Distribution of Compensation Payments Per Employee
"Other" Metal Mines, Annually, 1975-1985

Year	Direct: Pay For Time Worked (1)	Paid Time Off (2)	Other (3)	Indirect: Payments Required By Law (4)	Benefit Plans (5)	Total Indirect (6)
	(DOLLARS)					
	A					
1975	11,621	1,720	96	877	1,734	4,427
1976	13,713	1,821	121	1,292	2,402	5,636
1977	15,007	1,892	186	1,683	2,642	6,402
1978	13,858	1,673	214	1,382	2,537	5,806
1979	14,356	1,970	260	1,312	2,861	6,403
	B					
1979	16,187	1,471	141	1,904	1,847	5,363
1980	20,124	2,619	190	1,656	3,798	8,262
1981	21,388	2,834	222	1,845	3,709	8,610
1982	19,168	3,005	282	1,803	5,003	10,094
1983	23,336	3,064	455	2,183	3,923	9,625
1984	27,999	3,394	367	2,944	3,942	10,647
1985	30,022	3,876	546	3,460	4,404	12,287

Source: See Appendix Table 5.

Notes: See Appendix Table 5.

Appendix Table 8

Payments Required By Law, Cost Per Employee, By Category
Total Metals, Annually, 1975-1985

Year	Workmans' Compensation (1)	Unemployment Insurance (2)	Canada Pension Plan (3)	Silicosis (4)	Total (5)
			(DOLLARS)		
			A		
1975	531	158	120	47	856
1976	847	203	138	71	1,259
1977	1,175	205	159	93	1,633
1978	985	177	150	35	1,348
1979	914	171	150	34	1,282
			B		
1979	1,142	154	172	200	1,673
1980	1,463	250	254	163	2,129
1981	1,279	317	237	146	1,973
1982	1,448	279	277	156	2,154
1983	1,486	516	324	200	2,526
1984	1,826	607	338	239	3,010
1985	2,166	645	384	276	3,472

Source: See Appendix Table 5.

Notes: See Appendix Table 5.

Appendix Table 9

Payments Required By Law, Cost Per Employee, By Category
Gold and Iron, Annually, 1979-85

Year	Workmans' Compensation (1)	Unemployment Insurance (2)	Canada Pension Plan (3)	Silicosis (4)	Total (5)
			(DOLLARS)		
			A		
1979	1,132	199	230	402	1,979
1980	1,245	250	247	393	2,135
1981	1,252	367	282	455	2,334
1982	1,684	261	337	514	2,797
1983	1,463	493	405	510	2,871
1984	2,079	664	359	656	3,758
1985	2,204	564	402	744	3,915

Source: See Appendix Table 5.

Notes: See Appendix Table 5, Figures were not available for the years 1975-1979 in the original sample (Panel A, Appendix Table 5).

Appendix Table 10

Payments Required By Law, Cost Per Employee, By Category "Other" Metals, Annually, 1979-85

Year	Workmans' Compensation (1)	Unemployment Insurance (2)	Canada Pension Plan (3)	Silicosis (4)	Total (5)
			(DOLLARS)		
			A		
1979	1,059	123	133	95	1,410
1980	1,368	220	226	61	1,876
1981	1,288	300	222	42	1,852
1982	1,372	284	257	39	1,945
1983	1,494	524	294	87	2,400
1984	1,734	586	330	88	2,738
1985	2,153	673	378	114	3,318

Source: See Appendix Table 9.

Notes: See Appendix Table 9.

Appendix Table 11

Benefit Plans, By Category, Cost Per Employee
Total Mines, Annually, 1979-1985

Years	Private Pension Plans (1)	Provincial Medical Plans (2)	Life and Health Insurance (3)	Industrial Injury Benefits (4)	Other Benefit Plans (5)	Total (6)
			DOLLARS			
1979	675	336	440	125	83	1,660
1980	2,303	633	513	44	4	3,554
1981	2,201	646	513	12	50	3,473
1982	1,613	769	686	38	91	4,667
1983	2,017	876	656	43	82	3,683
1984	1,794	912	840	36	84	3,751
1985	2,049	659	1,007	22	322	4,147

Source: See Appendix Table 9.

Notes: See Appendix Table 9.

Appendix Table 12

Benefit Plans, By Category, Cost Per Employee
Gold and Iron, Annually, 1979-1985

Years	Private Pension Plans (1)	Provincial Medical Plans (2)	Life and Health Insurance (3)	Industrial Injury Benefits (4)	Other Benefit Plans (5)	Total (6)
			(DOLLARS)			
1979	380	383	310	82	1	1,154
1980	690	264	365	65	1	1,386
1981	565	283	488	58	4	1,398
1982	773	347	530	98	3	1,749
1983	537	342	650	98	5	1,704
1984	630	369	964	273	2	2,239
1985	417	371	867	135	3	2,026

Source: See Appendix Table 9

Notes: See Appendix Table 9.

Appendix Table 13

Benefit Plans, By Category, Cost Per Employee, "Other" Metal Mines, Annually, 1979-85

Years	Private Pension Plans (1)	Provincial Medical Plans (2)	Life and Health Insurance (3)	Industrial Injury Benefits (4)	Other Benefit Plans (5)	Total (6)
			DOLLARS			
1979	785	319	489	140	114	1,847
1980	2,484	674	529	42	5	3,798
1981	2,387	687	516	6	55	3,709
1982	1,710	817	703	31	101	3,361
1983	2,197	941	657	36	92	3,923
1984	1,941	980	824	6	94	3,942
1985	2,247	693	1,024	8	361	4,404

Source: See Appendix Table 9.

Notes: See Appendix Table 9.

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